

University of Nebraska - Lincoln

DigitalCommons@University of Nebraska - Lincoln

Theses from the Architecture Program

Architecture Program

Spring 5-8-2010

Piece to the Puzzle: Sustainable Elements Fitting Together

Heather C. Nelson

University of Nebraska at Lincoln, hnelson_04@hotmail.com

Follow this and additional works at: <https://digitalcommons.unl.edu/archthesis>



Part of the [Architecture Commons](#)

Nelson, Heather C., "Piece to the Puzzle: Sustainable Elements Fitting Together" (2010). *Theses from the Architecture Program*. 94.

<https://digitalcommons.unl.edu/archthesis/94>

This Article is brought to you for free and open access by the Architecture Program at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in Theses from the Architecture Program by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.

**Piece to the Puzzle:
Sustainable Elements Fitting Together**

By

Heather Nelson

Presented to the Faculty of
The College of Architecture at the University of Nebraska
In Partial Fulfillment of Requirements
For the Degree of Master of Architecture
Major: Architecture

Under the Supervision of Professor Sharon Kuska

**Lincoln, Nebraska
May, 2010**

Project Abstract

Sustainability, green, and eco-friendly are very popular topics right now. Those words and many like them are being used in almost every industry. But it's not just a trend, it's a necessary movement. Using green building elements as a starting point for design, just as site, typology, and clients' request are used, is how a sustainable building is created. These elements must be adjusted for every site because local materials, climate and community all play a role.

Deep investigation of the projects context is important. There are many factors of the site to consider. Physical aspects while important are just a small portion of site analysis. Climatologic data must also be analyzed, especially for sustainable buildings. City guidelines and codes should be known from the very start of design. It can also be useful to know the history and expected future of the site.

Speculative office buildings are flexible in plan allowing for changes without waste. It allows for different users to occupy the same space adding variety to the building. The addition of community space, such as a coffee shop, gives the building life after the nine to five workdays. A building like this can be beneficial in a small town.

An office building that embodies green architecture for a community that needs one is what sustainability is all about. This thesis project is to achieve that.



Table of Contents

Research/Analysis	7
Intent Narrative/Conceptual Design	27
Process Documentation	37
Final Design Documentation	61
Bibliography	87
Appendix	89
Acknowledgements and Dedications	115



Research/Analysis

Sustainable and Green are key words to eco-friendly architecture. Through research and analysis an understanding of the difference between the two, the relationship they have to each other, and what role they play into architecture design and building industry.



Sustainable – in general refers to the ability to maintain balance of a system, and that balance needs to be maintained over a long period of time. So sustainability must meet the needs of the current generation, but cannot compromise the ability of the future generation to meet their needs.

The movement toward sustainability is a movement towards redesigning society's needs so they can be accommodated with long-term carrying capacity of the environment.

Green: reduce many of the harmful impacts that buildings have on our environment and inhabitation.

Green is to design for energy efficiency, use renewable energy resources, create healthy indoor environments, specify building materials and resources that are sustainable, and provide efficient use of water.

Sustainable and Green have often be used interchangeably but they are very different. Green is actually a small part of Sustainability.

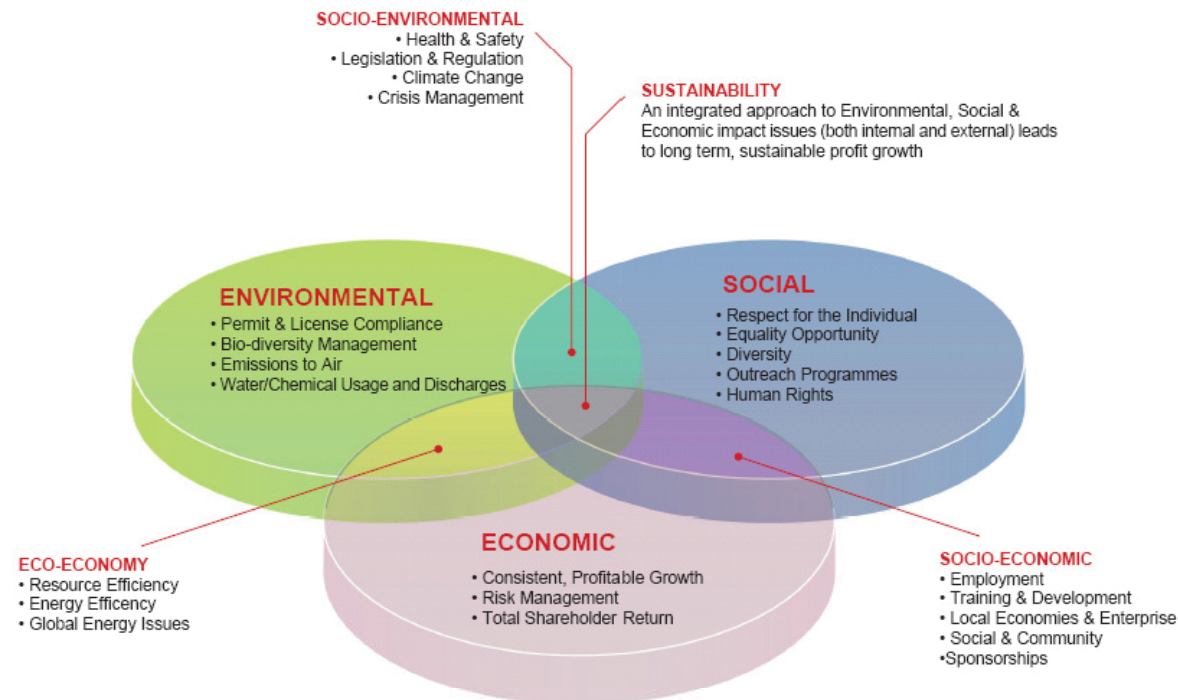
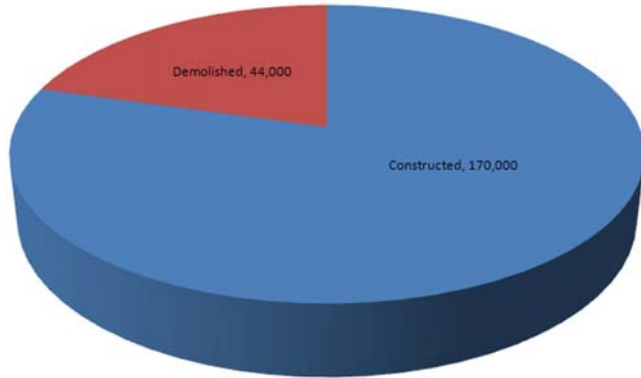
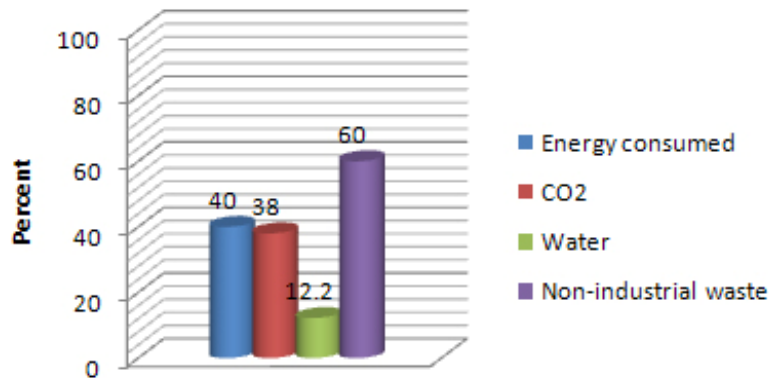


Diagram of Sustainability

There is an imminent need for sustainable or green architecture - Architecture that is beneficial to the owner/manager, occupants, visitors, and community; architecture that is responsive to the global needs of the planet and its resources. Green buildings save money by using less energy and fewer resources: they reduce heating, cooling, electricity, and water needs; they improve the quality of air and lighting, creating healthier and more productive occupants.



Estimate of the number of office buildings per year



Percentage of resources that a building consumes

- Buildings represent 38.9% of the U.S. primary energy use
- Buildings are one of the heaviest consumers of natural resources
- In the U.S. buildings account for 38% of all CO₂ emissions
- Buildings represent 72% of U.S. electricity consumption
- Buildings use 13.6% of all potable water, or 15 trillion gallons per year
- Buildings use 40% of raw materials globally (3 billion tons annually)
- 170 million tons of building-related construction and demolition debris was generated in the U.S. in 2003
- Around 5 million office buildings exist today
- Over 18% of the continental U.S. is developed

Source- (U.S. Green Building Council, Inc., 2009)

Precedence Study

There are a large number of sustainable buildings from the past and present. To help narrow the search and be more applicable to this project limits where set to 50,000 square feet and commercial office spaces, for a precedence study. Sustainability can be achieved in a number of ways: three of which are LEED, Passive, and High Performance. These three cover different approaches and examine a range of sustainable methods.

LEED – Leadership in Energy and Environmental Design, a program of the U.S. Green Building Council (USGBC), was designed to evaluate environmental performance from a whole building perspective over the life cycle of the building. LEED provides a definitive standard for what constitutes a green building in design, construction, and operation.

The LEED ranking systems are designed for rating new and existing commercial, institutional, and residential buildings.

The ranking systems are organized into five environmental categories.

Sustainable Site - 26 pts.
Water Efficiency - 10 pts.
Energy and Atmosphere - 35 pts.
Materials and Resources - 14 pts.
Indoor Environmental Quality - 15 pts.

The points a project earns are added together to determine what level of certification it shall receive.

Certified - 40 – 49 pts.
Silver - 50 – 59 pts.
Gold - 60 – 79 pts.
Platinum - 80 – 100 pts.

An additional category, Innovation in Design (6 pts.) addresses sustainable building expertise as well as design.

Finally, Regional Priority (4 pts.) acknowledges the importance of local conditions in determining environmental design and construction.

A problem of LEED lies here in the point and certification system. All too often the point system is used as a check-list late in the design development stage of a project. The result is often marking off what the project has and tacking on what is needed to reach a certain level of certification. This creates buildings that do not embody sustainability, but use sustainability like ornamentation.



Santa Clarita Transit Maintenance Facility
Santa Clarita, CA, 2005, 22,000 SF, Gold

Rice Straw bale envelope

- Local rice bales would normally be burned

Under-floor Air Distribution

High Performance Glazing

- Clerestory and Skylight daylighting

Stormwater collection and treatment

Water efficient fixtures and grey water reclamation system

Local recycled Materials



Winrock International Global Headquarters
Little Rock, AK, 2004, 24,000 SF, Gold

Oversized Gull-wing Roof

- Blocks sun
- Collects rain water

75% recycle rate

- Created recycling infrastructure for the city

Under-floor Air Distribution

- Later added water source geothermal heat pump

Fixed windows



Tarlton Corporation Headquarters
St. Louis, MO, 2004, 21,000 SF, Silver

North window daylighting

Brownfield Redevelopment

Construction Waste Management

Recycled and Low-emitting Materials

Locally Manufactured Materials

Passive – buildings that do not use mechanical, but natural, means to light, heat, cool and/or ventilate their spaces.

Passive Lighting – optimizes natural sunlight to illuminate the space. The use of windows, clerestories, and skylights allow sunlight into the spaces. Light shelves can reflect light and give indirect light to spaces. The concerns of passive lighting are the amount of heat gain, UV rays, and glare that can affect the space.

Passive HVAC – uses the sun to heat spaces, and air movement to cool and ventilate spaces. The use of operable windows and wing walls bring in air for ventilation. Thermal chimneys move the heat out of a space, and thermal masses release heat into the space.

Many historic buildings were designed passively out of necessity. Before electricity or mechanical systems, passive means was the only way to light, heat, or cool spaces. Now buildings are doing so to eliminate energy costs.



Eastgate Center
Harare, Zimbabwe, 1996, 31,600 SM, Biomimicry

Modeled after African Termite Mounds

Mostly Naturally Ventilated and Cooled

- Uses 10% of the energy

Deep overhangs shade out summer sun

- Low- winter sun can get in

Constructed of available local resources



Larkin Building
Buffalo, NY, 1906 – 1950, 5 stories, Daylighting

Occupiable Roof

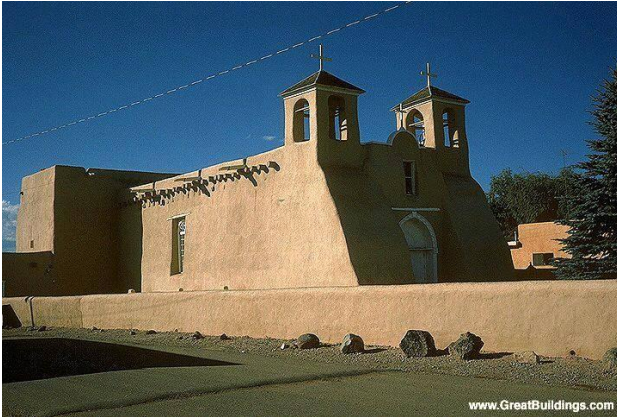
Central atrium brought in daylight

Air-conditioned

- Sealed windows

Built to withstand time

Demolition waste was reused



San Francisco de Asis Mission Church
Ranchos de Taos, NM, 1772, 4,400 SF, Adobe

Only Local Materials

Thermal Mass walls

Indirect Natural Lighting

Cross ventilation and thermal chimneys

High Performance – buildings that can meet or exceed LEED criteria. They can also focus to be more sustainable in the building's energy usage.

Near zero, net-zero, and positive energy buildings are examples of high performance buildings. They generate the equivalent of the energy they use; by a combination of energy generation and efficient systems.

With an increase in technology high performance architecture is getting more and more effective. Increase in efficiency and practicality leads to more successful projects.



Eliithis Tower
Dijon, France, 2009, 54,000 SF, Positive Energy

Emits six times less greenhouse gases

Environmentally friendly materials

Primarily uses daylighting

Recycles internal heat gain

330 solar panels on the roof



NASA "Sustainable Base" Ames Research Center
Moffett Field, CA, Construction, 50,000 SF, Zero-net Energy

Near zero energy consumption

Uses 90% less potable water

Intelligent control technology

Ground source heat pumps

Solar water heating

Site stormwater management

Greensburg, Kansas

The project location is downtown Greensburg, Kansas. The town is in need of office spaces as they rebuild to be a sustainable city. Already completed buildings can be example of what the city wants and the sustainable elements that they wish to characterize.

City of Greensburg, Kansas – Is located in the southwest part of Kansas. Greensburg was incorporated and named Kiowa County seat in 1886. In the 1960s Greensburg's population peaked at around 2,000 individuals. The population in 2006 was 1,389. It is home of two tourist attractions: The Big Well and a Pallasite Meteorite. The Big Well is the world's largest hand-dug well, and the Pallasite Meteorite is a 1,000 lb. meteorite making it also the world's largest.



Historic Postcard of Downtown Greensburg

Greensburg was like any other Small Town America. It had a medium age of 45.6 years; with mostly only a high school education for those over 25. The average per capita income was \$18,054 in 2000. Greensburg's economy was based in the agricultural tradition along with the railroad and oil. The county's chief crop is wheat. The largest employers of Greensburg are the school, hospital, and the city and county government offices.



Downtown Greensburg after May 4th, 2007's EF-5 tornado

On May 4th, 2007 an EF-5 tornado hit Greensburg, KS, destroying 95% of the town and killing eleven people. In its wake the community set forth to rebuild a prosperous future through sustainable community design. Recovery and Comprehensive plans were developed through community input to help the community become a socially, economically, and environmentally sustainable city for current and future generations.

Greensburg, KS – as the city builds it encourages sustainability with incentives through a number of programs that have been created. All public facilities that are city, county, or state owned are to be designed to LEED Platinum criteria; and all other public buildings are encouraged to do the same.



547 Art Center
2008, 1,670 SF, Gallery and Interpretive Center, Platinum

3 – 600 watt wind turbines and 8 roof mounted solar panels

Ground source heat pumps and thermal mass floor

Reclaimed wood and recycled materials

Green roof

Operable skylights

Collected rainwater is used for irrigation



Business Incubator
2009, 9,580 SF, Retail and Commercial, Platinum

Use of daylighting

Ground source heat pumps

Solar panels provide 10% of energy

Grey water system

Stormwater control

Storm reserment materials

Intent Narrative/Conceptual Design

What elements exist which, chosen from categories of an array based on characteristics and interrelationships, will combine to create a green building?



Thesis Narrative

Sustainability cannot be added onto the end of a project. Sustainability will only be successful when green building elements are incorporated throughout a project.

Each project is unique; site, type, and community all needs to be considered in order for it to be sustainable.

It is important that each green building element be considered for each project. These elements need to be evaluated by how well they work with other building or green elements, structure typology, and site.

Concepts



Interlocking connection – Green elements are dependent on each other in order to create a functional building. Each element displays its own characteristics and its interrelationships with other elements.



Smooth connection – Each green element is independent from the others. One element could change or be eliminated without changing the project. The elements characteristics are displayed but not their interrelationships to each other



Blended connection – The green elements relies on each other creating a complete project. Each element has their own characteristics and interrelations but they may not be obvious.

The last concept is in the spirit of sustainability. Each element needs the other for the project to be fully functioning ecologically, economically, and logistically. However, the esthetics of the building cannot rely only on the interactions and raw characteristics of each element.

























Matrix development


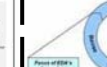




















It is important to understand different green building elements and how they work or don't work with other elements for each project. A matrix could be used to lay out green elements into categories.

The five LEED environmental categories plus the Regional Priorities lend themselves well to be the categories of the matrix. A number of areas are located within each category. A number of green elements lie within each area.


Simple icons are used to make reference throughout the matrix easier. These icons illustrate each category, area, and element.

The matrix is used by moving from the categories to areas to the green building element that is of interest. Each element has a page that shows the function, characteristics, and positive and negative relationships. This outlines ways to effectively use each green building element for each project.

Sustainable Site					
Water Efficiency					
Energy & Atmosphere					
Materials & Resources					
Indoor Environment Quality					
Regional Priority					

Sustainable Site						
Storm Water						
Transportation						
Heat Island						
Light Control						

See Appendix (pg. 91) for complete matrix.



CHARACTERISTICS:
Comes in a variety of styles that may be appropriate for different building/roof type. Can be selected from a variety of colors and materials. Each has their own solar reflectance and thermal emittance.



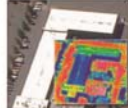

FUNCTIONAL RELATIONSHIPS:

POSITIVE:
Good with most roof types and shapes. Can be used with Storm Water Collection systems. Energy efficient.

NEGATIVE:
Can not be used with a Green Roof system, can be used next to one.

BENEFITS:
Reflects heat, Energy savings, Works in a variety of locations and roof type, Aids in the mitigation of the urban heat island.

LIMITATIONS:
Does not work on every roof in every location, Over time climate, solar radiation and pollution can reduce solar reflectance, Requires regularly scheduled upkeep and cleaning

Process Documentation

A functional project must work through how program, climatologic data, local design guidelines, and site combine in schematic design and a project matrix.



Program

Speculative Office building with multiple office suites, public conference room, and community coffee shop.

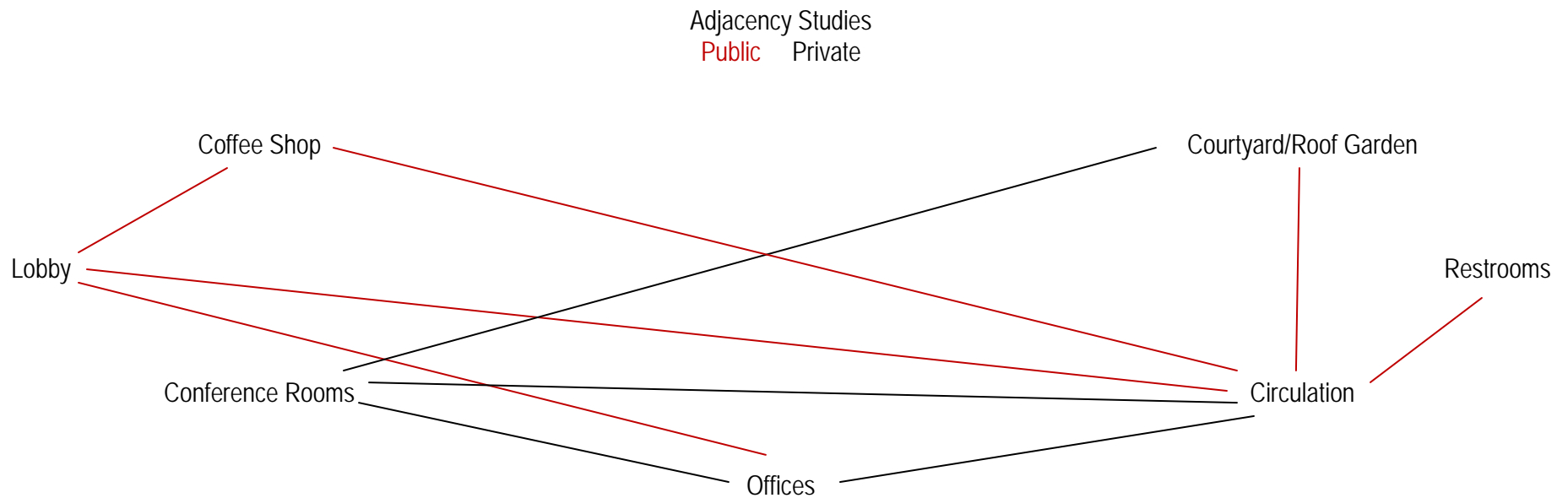
Five open plan offices ranging from 2,125 to 3,210 square feet. Three are on the ground floor and two on the second floor. Two shared conference rooms, one per floor.

Bicycle storage and changing/shower rooms.

Shared work rooms.

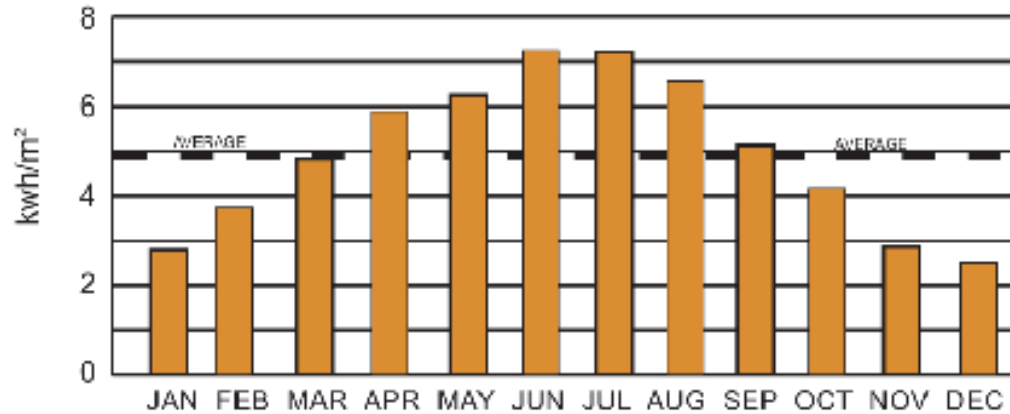
Public and private courtyard and roof garden.

Atrium type lobby with coffee shop.

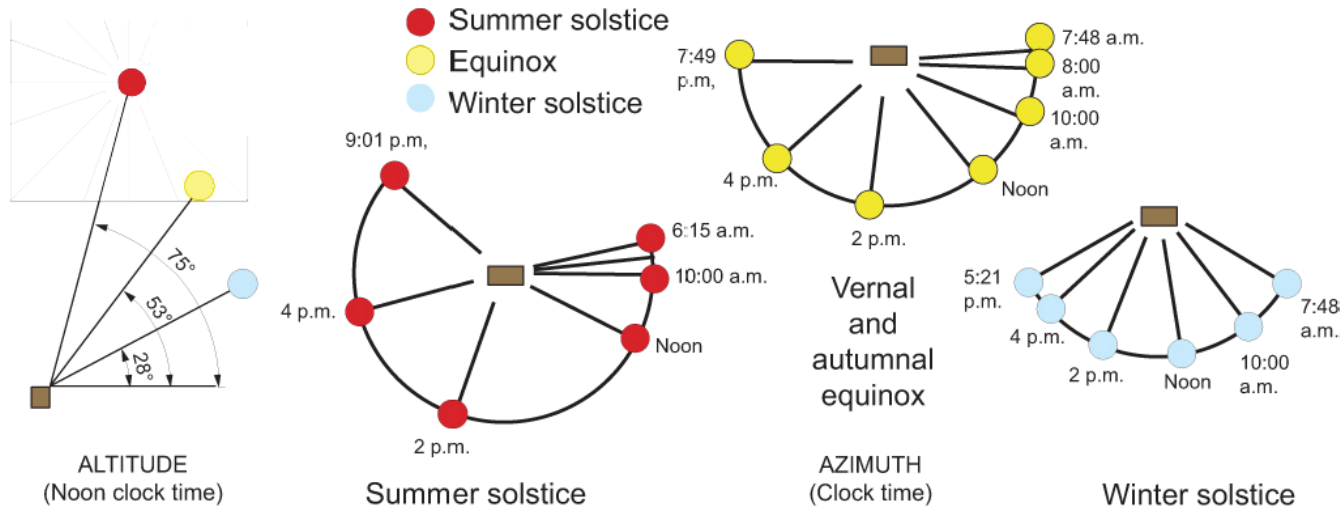


Greensburg, KS Climatologic Data

Solar – Greensburg’s high sun angles in the summer months suggest shading devices that allow for the lower winter sun to penetrate. The amount of solar radiation in the summer and high average electromagnetic energy suggest that solar collection is good year around.

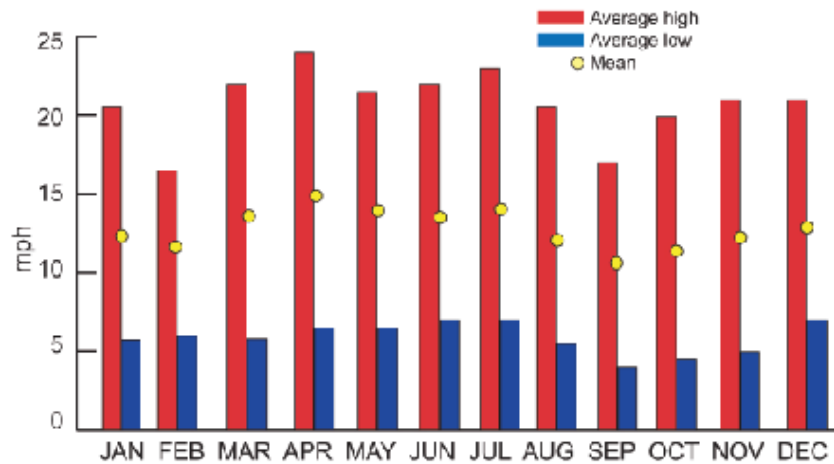


Average daily horizontal solar electromagnetic energy

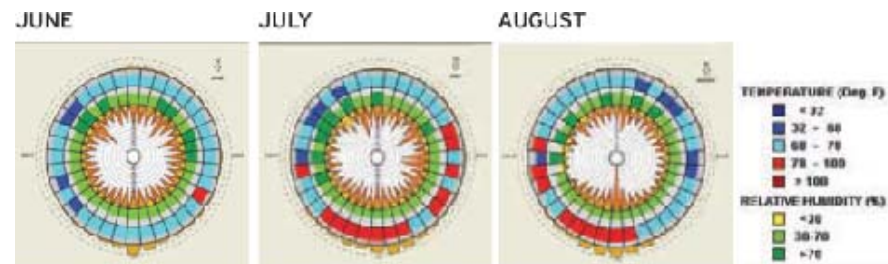


Sun extreme angles

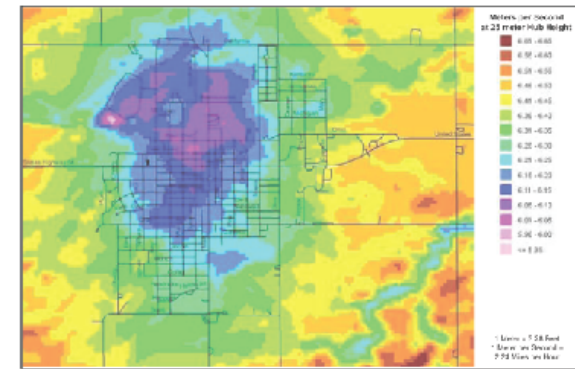
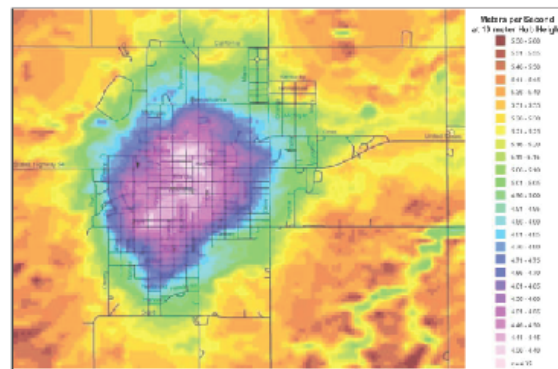
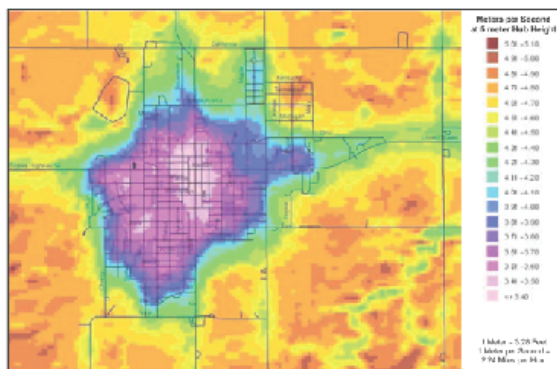
Wind – Greensburg is in one of the windiest part of the U.S. Wind speed averages remain consistently high year around. Spring brings the highest gust and summer brings south winds that can add ventilation, building cooling, and fresh air. Harvesting wind is a viable option for energy.



Average minimum, maximum monthly wind speeds

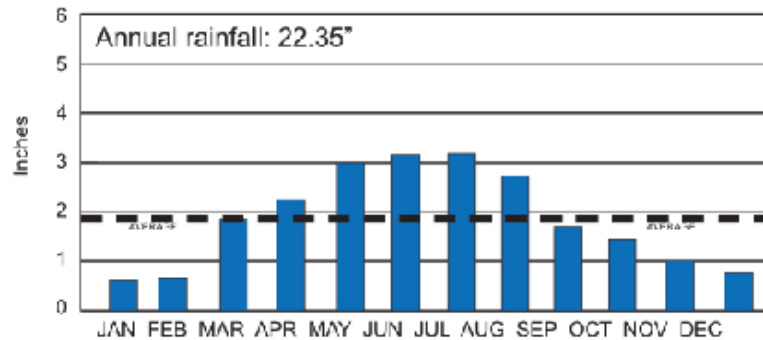


Wind speed and direction for summer



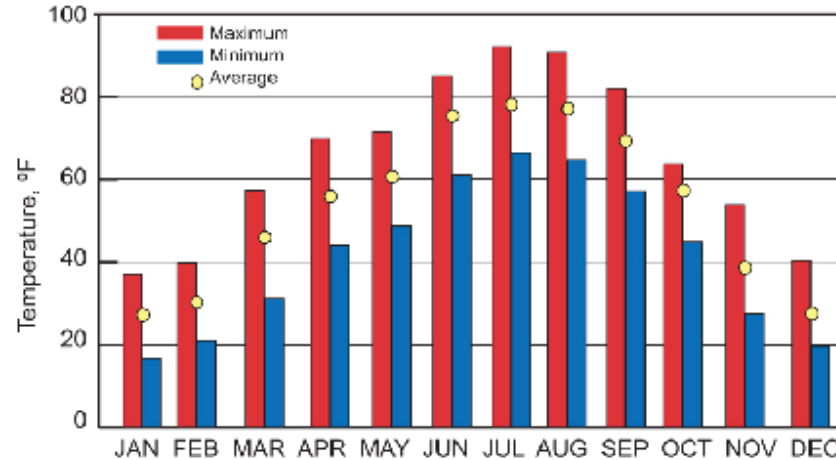
City wind speeds by elevation

Rain – Water is a precious resource for Greensburg. A low annual rainfall indicates that rainwater cannot meet the building's water requirements. But collection and conservation is important to reduce water demands.

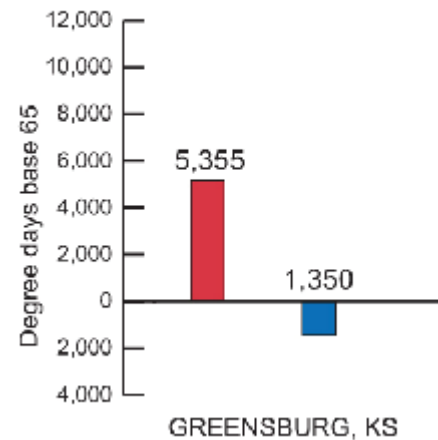


Average monthly rainfall

Temperature – Greensburg lies in a cold, humid climate zone. Summer temperatures are high while the temperature in the winter can be frigid. The average diurnal swing is 24 degrees.



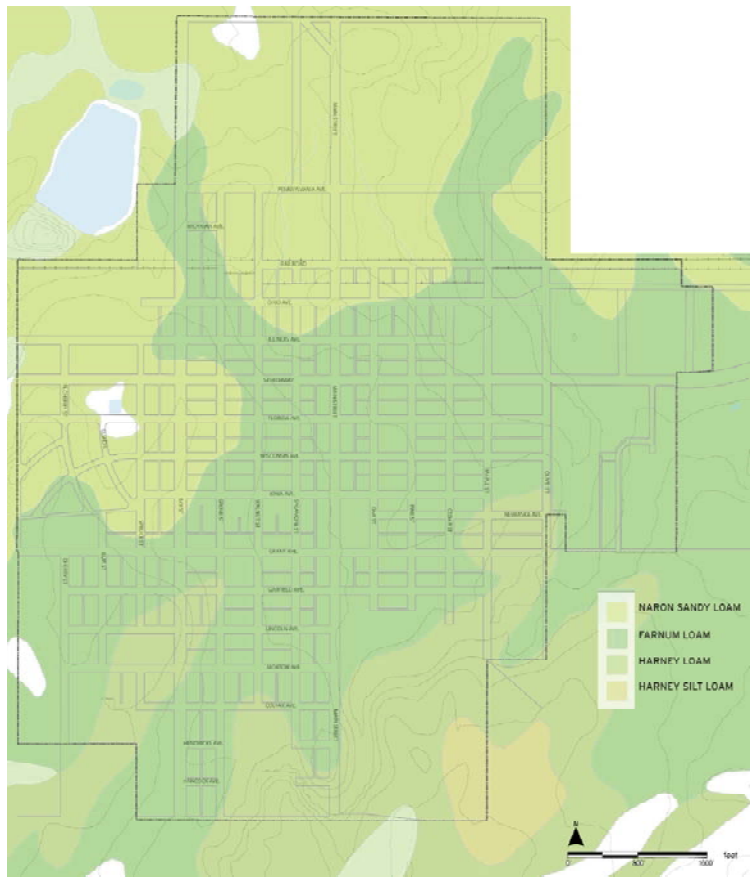
Average minimum, maximum and monthly temperatures



Heating and cooling degree days

Heating and cooling degree days – Space heating is more important than space cooling.

Soil – The loam soil of Greensburg drains well and is nutrient rich. The dryness of the loam soil makes it not an ideal soil for geothermal heat pumps



Soils of Greensburg, KS

Native Plants – Plants native to Greenburg are accustomed to the local climate. They require little water and adapt for the change in seasons. Native plants are ideal for courtyard and green roof plantings.

**Forbs and
Wildflowers**

Ashy Sunflower
Black Eyed Susan
Blanket Flower
Butterfly Milkweed
Compass Plant
Plains Larkspur
Heath Aster
Hoary Puccoon
Indian Paint Brush
New England Aster
Prairie Coneflower
Curled Dock
Purple Prairie Clover
Rocky Mountain
Zinnia
Rose Verbena
Spiderwort
Stiff Goldenrod
Giant Goldenrod
Thickspike Gayfeather
Big Flower Coreopsis
Wild Hyacinth
White Beardtongue
White Wild Indigo

Grasses and Sedges

Big Bluestem
Blue Grama
Bottlebrush Sedge
Buffalo Grass
Burr Reed Sedge
Bushes Sedge
Canada Wild Rye
Fox Sedge
Great Plains
Flatsedge
Fowl Managrass
Indian Grass
Leavenworth's Sedge
Little Bluestem
Prairie Cordgrass
Prairie Dropseed
Porcupine Sedge
Rattlesnake Grass
Rice Cutgrass
Side-Oats Grama
Switch Grass
Common Scouring
Rush

Shrubs and Trees

Aromatic Sumac
Ash
Black Jack Oak
Bur Oak
Chinquapin Oak
Dogwood
Eastern Cottonwood
Hackberry
Kentucky Coffee Tree
Lead Plant
New Jersey Tea
Osage Orange
Pawpaw
Pin Oak
Redbud
Red Cedar
Red Oak
Sand Sagebrush
Sycamore
Wahoo
Yucca

Greensburg Comprehensive Plan and Design Guidelines – Greensburg has developed an extensive Master Plan and list of Architecture Design Guidelines.

The community of Greensburg believes that function should be the primary architecture feature in Greensburg. By combining functional design with modern technologies and materials, Greensburg can create an integrated downtown core that reveals the individual character of the businesses while maintaining the overall character and the goals to become a model of sustainability. Greensburg's style will represent the community's history and progressive spirit.

Some of the more prominent architectural features from the Architectural Design Guidelines that were important to follow were the requirements of sixty percent glass on the ground level Main Street facade and buildings that take up three or more lots should include architectural details that divide the building into smaller portions. Massing was used as a means to incorporate daylight into the building, create unique character and interesting spaces, and create variety in the pedestrian facade.

Design guidelines that were not followed were only eliminated after careful consideration of appropriateness. For single story facades the guidelines require a minimum height requirement of twenty feet. With a fifteen foot roof elevation, five foot parapet was unnecessary, a three foot parapet that doubles as a guard rail seemed more efficient. The guidelines also suggested that brick be used as a façade treatment, but with concrete walls a brick veneer would be only ornamentation.

The creation of a pocket park adds green space to the block and allows the south sun in for daylighting. The courtyard can be used for both the building occupants and public.



See Greensburg, KS homepage, greensburgks.org, for their comprehensive plan

ARCHITECTURE DESIGN GUIDELINES

The Hundred Year Building

- Is the building construction and materiality such that it will age gracefully and require minimal maintenance? (p. 8)

☒ ☒

ARCHITECTURAL EXPRESSION

- Does the architectural style and expression fit in with surrounding buildings? (It should not dominate or overwhelm neighboring structures.) (p. 8)

☒ ☒

BUILDING USES

- Does the project incorporate a variety of uses or add a new use to the block where it is located? (p. 9)

☐ ☒

RESIDENTIAL USES

- If a project on Main Street or Kansas Avenue includes second or third story residential spaces, are their private entrances located in the alley or on side streets? (p. 9)
- Do first story entrances on side streets encroach no more than five (5) feet onto the right of way? (p. 9)

☐ ☐
☒ ☐

GROUND FLOOR USES

- Are first story spaces on Main Street and Kansas Avenue reserved for commercial or retail uses? (p. 10)
- Are the primary commercial and retail entrances located on Main Street or Kansas Avenue? (p. 10)
- If sidewalk cafes have more than one row of seating, do the plans include a railing or other barrier between the seating area and the sidewalk? (p. 10)

☒ ☒
☐ ☒
☐ ☒

MASSING AND ARTICULATION

BUILDING HEIGHT

- If the project is on a corner lot, does it achieve a height of thirty-five (35) feet (two stories)? (p. 11)

☐ ☐

MASSING DIVERSITY

- Does the building use creative massing to incorporate natural light and views? (Creative massing should have a distinct purpose.) (p. 11)

☐ ☒

MATERIALS

DURABLE, HEALTHY, AND EFFICIENT MATERIALS

- Are the building's structural materials durable? (p. 15, 17)
- Does the building incorporate recycled, reused, rapidly renewable, and/or locally harvested materials? (p. 16)

☒ ☒

FAÇADE MATERIALS

- Does the facade incorporate more than one material or color to avoid monotony? (p. 16)
- Does the facade use bright colors only for detail and earth tones or raw materials for larger areas? (p. 16)
- Does the facade use brick, stone, precast concrete, wood, metal, or glass and avoid vinyl siding or mirrored glass, artificial or simulated materials, and reflective glass? (p. 16)

☐ ☒
☒ ☒

INTERIOR MATERIALS

- Does the interior use finishes and furniture low in toxins and volatile organic compounds? (p. 17)

☐ ☒

PUBLIC ART

- If a project incorporates public art, does it help visitors understand the history and/or future goals of Greensburg? (p. 17)
- Public art should not interfere with the streetscape or inhibit walking, biking, or driving. (p. 17)

☐ ☒
☒ ☒

FENESTRATION AND TRANSPARENCY

DAYLIGHT AND HEAT GAIN

- Do window or door openings on the east and west sides of a building have controls, such as shading or blinds? (p. 18)
- Are windows in offices or residential spaces operable? (p. 18)

☐ ☒
☐ ☒

PATTERN

- Are windows well proportioned and do they establish a rhythm with the building and neighboring structures? (p. 19)

☒ ☒

TRANSPARENCY

- Do ground floor architectural details incorporate at least 60% transparent materials? (There is no maximum requirement.) (Opaque and translucent glass does not qualify as transparent materials.) (p. 10, 18)
- Do second and third floors incorporate at least 30% transparency? (There is no maximum requirement.) (p. 19)

☒ ☒
☒ ☒

ENTRANCE IDENTITY

- Are doors and building entrances easily located and accessible? (p. 10, 19)
- Do entrances offer protection from the elements and establish relationships between public and private domains with architectural details and materials that contribute to the cultural identity of Greensburg? (p. 19)

☒ ☒
☐ ☒

PROJECTIONS

AWNINGS, CANOPIES, SUNSHADES AND CORNICES

- Do awnings, canopies, sunshades and cornices provide adequate clearance for pedestrian traffic? (p. 12)
- Do projections fit in with streetscape elements? (p. 12)
- So second or third story projections, including balconies, extend no more than three (3) feet beyond the property line? (p. 12, 13)
- Do first story cornices project no more than three (3) feet? (p. 13)
- Are projecting elements created from appropriate, durable materials? (p. 12)
- Are projecting elements safely mounted to the building? (p. 12)

☒ ☒
☐ ☐
☐ ☐
☐ ☐

BALCONIES AND PROJECTED WINDOWS

- Is there at least a twelve foot vertical clearance between the projecting element and the sidewalk? (p. 13)
- Do first story projecting windows extend no more than one (1) foot beyond the property line? (p. 13)

☒ ☐
☒ ☐

SIGNAGE

- Do individual storefront signs maintain a pedestrian scale? (p. 14)
- Is the signage ground-lit or otherwise washed with light from a concealed light source? (Signs should not be back-lit or include digital displays.) (p. 14)
- Does the business have no more than one blade sign that does not exceed six (6) square feet? (p. 14)
- Is the blade sign installed at a height that prevents physical contact with pedestrians? (p. 14)
- Are sign materials complementary and consistent with architectural materials, and are they durable and easily maintained? (p. 14)

☐ ☐
☐ ☐
☒ ☐
☒ ☐
☐ ☒

ROOFS AND PARAPETS

- If a building incorporates two or more pitches in its roof structure, is it designed for adjacent properties to abut on either side, and does it allow for proper drainage away from existing or future buildings? (p. 14)
- If the design includes parapets, do they achieve visual interest by including special architectural details, stepping, or slopping? (p. 14)
- If the design includes parapets, do they seek harmony with adjacent parapets but avoid strict consistency? (p. 14)

☒ ☒
☐ ☐
☐ ☐
☐ ☒

KEY SITES/CORNERS

- If the building is on a corner lot, does it create a gateway to downtown and provide a means of wayfinding? (p. 20, 29)

☐ ☐

LIGHTING

- Is exterior lighting on individual buildings kept to a minimum? (p. 20)
- Does lighting highlight architecture design features or public art displays and/or enhance pedestrian safety? (p. 20)
- Does lighting avoid glare and excessive vertical luminance levels? (p. 20)
- Does lighting design create quality color? (p. 20)
- Does lighting incorporate energy efficient bulbs and/or fixtures? (p. 20)

☒ ☒
☐ ☒
☐ ☒
☐ ☒
☐ ☒

WATER

- Does the building reduce the amount of potable water used in the facility with no and low-flow toilets, faucets, shower fixtures, and efficient equipment? (p. 21)
- Does the building incorporate biological treatment to recycle graywater and wastewater and cisterns or other innovative storage systems to capture rainwater for non-potable uses? (p. 21)

☐ ☒
☐ ☒

ENERGY

- Does the building have an energy efficient and well-insulated building envelope? (p. 21)
- Does the building use high efficiency heating/cooling systems, fixtures and appliances? (p. 21)
- Does the building have effective daylighting design that minimizes the need for electric lighting? (p. 21)
- Does the building incorporate signature renewable energy sources on-site? (p. 21)

☐ ☒
☐ ☒
☐ ☒
☐ ☒

SITE DESIGN GUIDELINES

SITING AND ORIENTATION

SETBACKS

- Does the building set back no more than five (5) feet from the front property line? (p. 25)
- If the building is set back, does the setback have a functional purpose or enhance the street wall? (p. 25)

REQ'D ✓

☒ ☒

GAPS

- Does the building footprint fill the width of its parcel to avoid gaps on Main Street? (p. 26)
- Is the building designed so a neighboring building can abut on the north and south sides, or does it create a pocket park within the parameters below? (p. 26)

☒ ☒

POCKET PARKS

- Is the pocket park accessible from the public sidewalk? (p. 24, 26)
- Does the pocket park facilitate and block circulation from alleyways to Main Street? (p. 26)
- Does the pocket park incorporate seating, hard and soft landscapes, and a central design feature? (p. 26)
- Does the pocket park reduce runoff and/or creatively store stormwater for reuse? (p. 26)
- Pocket parks should not exceed one parcel width or twenty-five (25) feet and should be at least fifteen (15) feet wide. (p. 26)
- Downtown blocks should have no more than two pocket parks. Does the project maintain this limit? (p. 26)

☒ ☒ ☒ ☒ ☒ ☒

TEMPORARY GAPS

- Are temporary gaps landscaped and maintained by the landowner until further development occurs? (p. 26)

☐ ☐

CONSISTENCY AND SCALE

- Does a single building use no more than three parcels? (p. 27)
- If more than three parcels are used, is the building facade articulated to maintain a human scale? (If a development in one half to one block it should use two different architects or architectural styles.) (p. 27)
- Does the project maintain current parcel size unless the parcel is being split to to create a pocket park, mid-block crossing, or view corridor? (p. 27)

☒ ☒ ☒ ☒

SUSTAINABLE SITE STRATEGIES

FOOTPRINT / LOT COVERAGE

- Does 20% of the lot consist of permeable surfaces or open space? (p. 28)

REQ'D ✓

☒ ☒

SOLAR ORIENTATION

- Do buildings work together to create optimal solar orientation with varied building stories and building tiers? (p. 28)

☐ ☒

HIERARCHY

MAIN STREET CORRIDOR

- Are all service or secondary entrances (including loading docks) located on the alley? (p. 29)

☒ ☒

SECONDARY / TERTIARY STREETS

- Does development facing the alleys and side streets reflect the qualities of downtown as a whole in terms of materiality, access to light, and landscaping? (p. 30)
- Are alleys kept open as secondary access-points to businesses and other uses? (p. 30)
- Are trash and recycling containers located in alleys and screened through the use of low walls or landscaping? (p. 30)
- Is the pavement in alleys appropriate for vehicular, pedestrian, and bicycle traffic, and does it properly manage stormwater? (p. 30)

☐ ☐ ☒ ☒ ☒ ☒

PARKING

- Does the project satisfy parking needs with on-street parking? (p. 31)
- If extra surface parking is required, is it placed behind buildings, and is it shared between daytime and nighttime uses? (p. 31)
- Are surface parking lots properly screened from neighboring parcels with landscaping, natural, high quality materials, or a fence with a height no greater than four (4) feet? (p. 31, 35)
- Do surface parking lots use high reflectant materials, an open grid, pervious pavement system, or appropriate vegetative shading to reduce heat island effect? (p. 31)
- Do surface parking lots use permeable pavement systems and/or stormwater collection and storage to help slow or decrease runoff? (p. 31)
- If the plan includes additional surface parking, does it identify priority parking for hybrid or alternative energy automobiles? (p. 31)

☐ ☐ ☒ ☒ ☒ ☒

ICONS, LANDMARKS, AND GATEWAYS

ICONS AND LANDMARKS

- Are historic or new icons and landmarks woven into the fabric of the city with visual connections such as vertical design elements, paths, and signage? (p. 32)

REQ'D ✓

☐ ☒

PLACEMAKING AND WAYFINDING

- Do signs, paths, and other visual elements aid in wayfinding and create a rich, referential and memorable experience for residents and visitors? (p. 33)

☐ ☐

EASEMENTS AND SIGHTLINES

- Does the project plan protect the visual connection between the County Courthouse and the Big Well and City hall? (p. 33)
- Does the plan create sightlines that connect important elements in town? (p. 33)

☒ ☒ ☐ ☐

GATEWAYS

- Does the project plan use signage, architectural details, public art, or signature landscaping features to create gateways that signify arrival into downtown? (p. 20, 29, 34)
- If yes, are the gateways simple in design rather than complex or flamboyant? (p. 34)

☐ ☒ ☐ ☒

LANDSCAPING

- Are native or Xeric plants used? (p. 35)
- Do additional planters use durable materials and harmonize with the Main Street streetscape design? (p. 35)

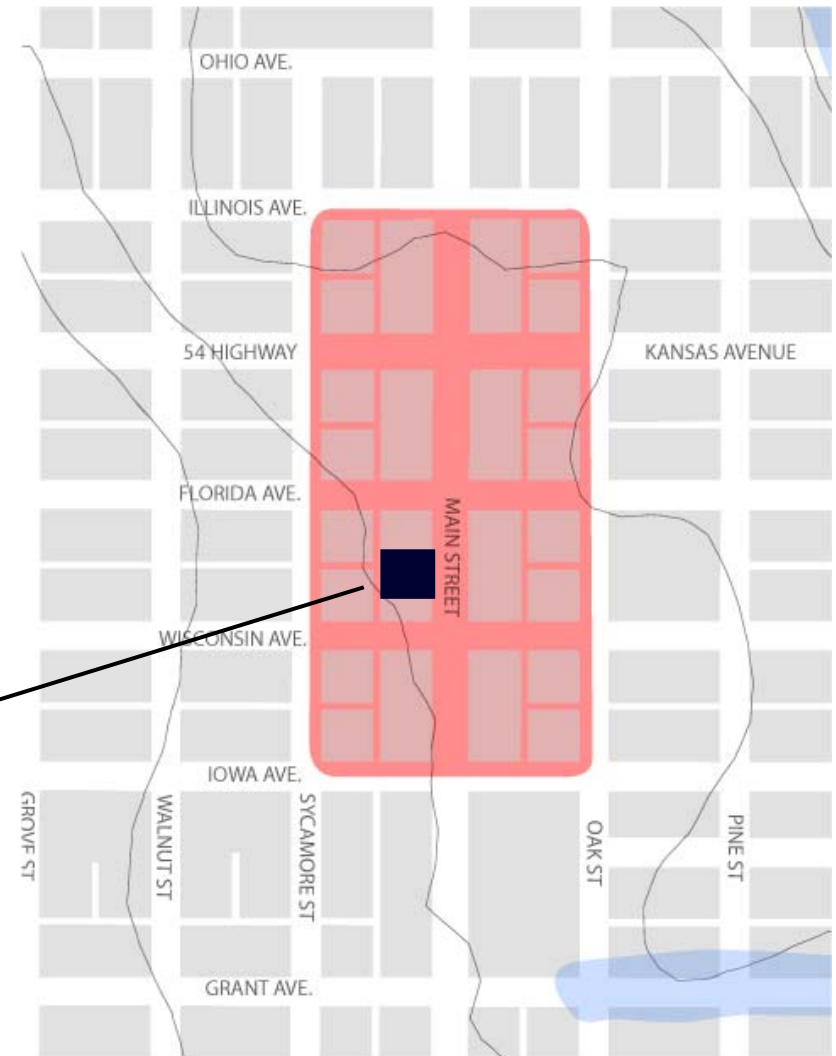
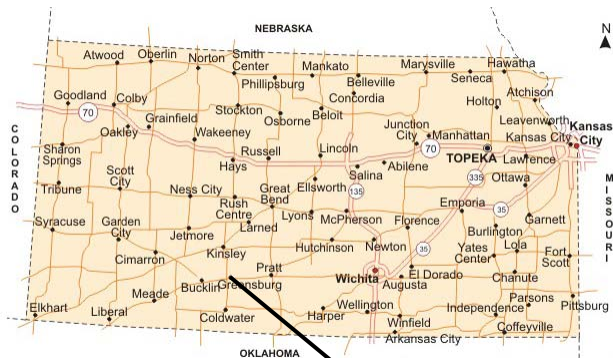
☐ ☒ ☐ ☐

WATER

- Do project sites naturally manage stormwater with rain gardens and/or bios-wales? (p. 36)
- Are storage systems, such as rain barrels or cisterns, used to capture rain-water for reuse? (p. 37)
- If the project plan incorporates paved areas, are pervious options used to reduce run-off quantities? (p. 37)

☐ ☒ ☒ ☒

Site Location – The site is centrally located site in the core of downtown. The site is located on Main St. between Florida and Wisconsin Aves.



Site Description – The site is level and five lots wide (150 feet by 130 feet). There is a newly constructed building to the north that has a brick façade and metal siding side walls. An existing basement is located on the site along with a rock wall on the south property line. The main public facade is to the east along Main St.



Look at the site form across Main Street



Look at Main Street from within the site



Newly constructed building that neighbors the site to the north.



Basement that is located in the site



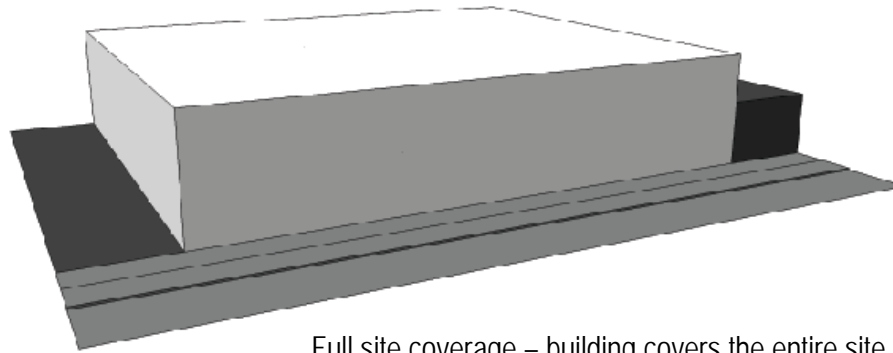
Existing rock wall that edges the south and southeast boundary of the site



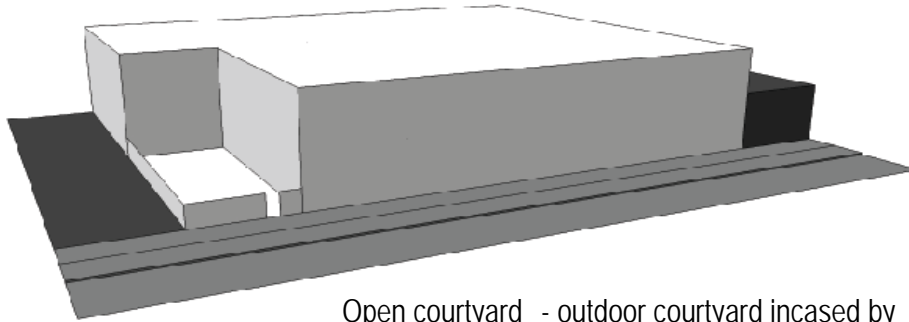
Remnants of a terracotta tile drive.

Schematic Design

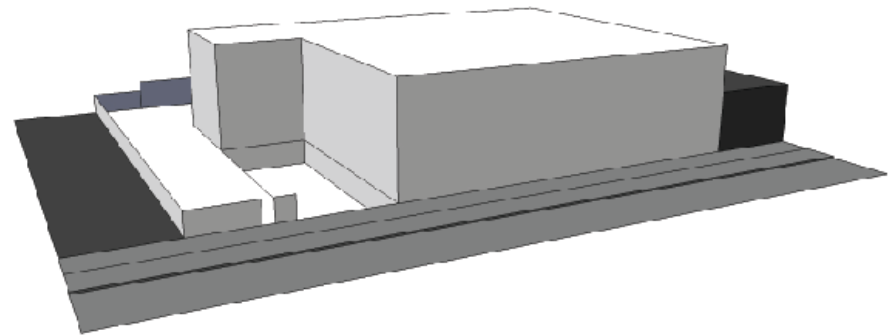
Volume/Area Studies



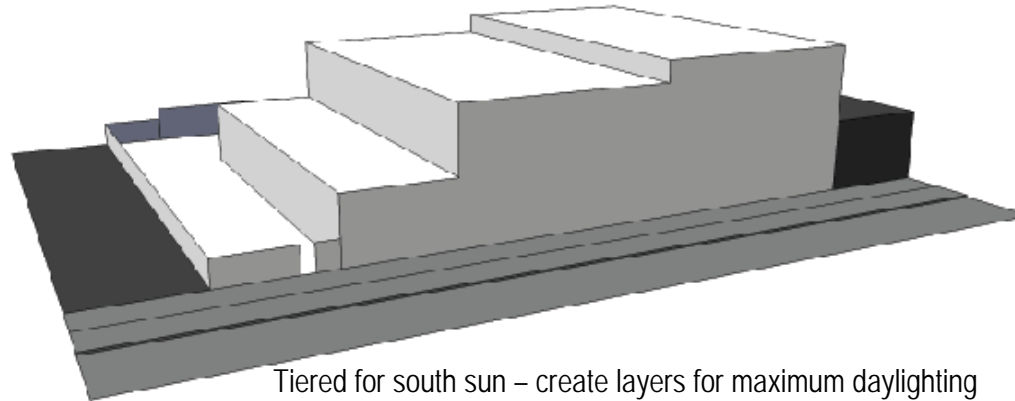
Full site coverage – building covers the entire site



Open courtyard - outdoor courtyard incased by Building and existing wall

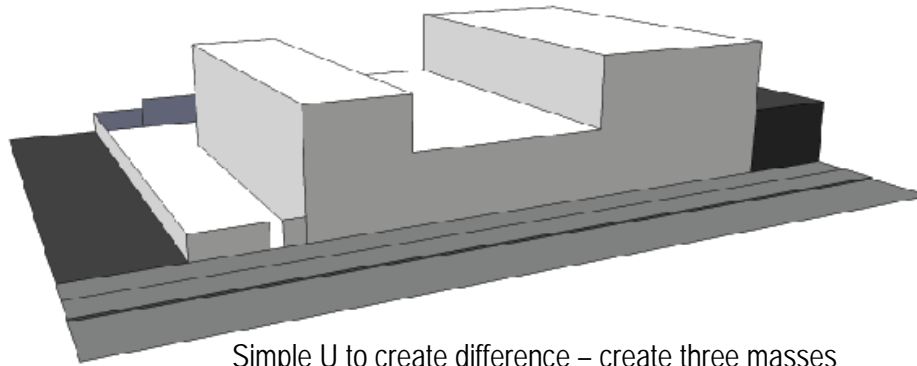


Larger courtyard and uncovered basement – courtyard extend to the alley and opens to the existing basement

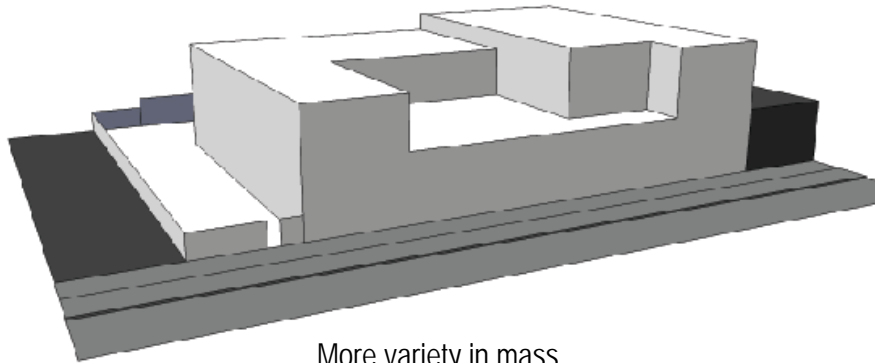


Tiered for south sun – create layers for maximum daylighting

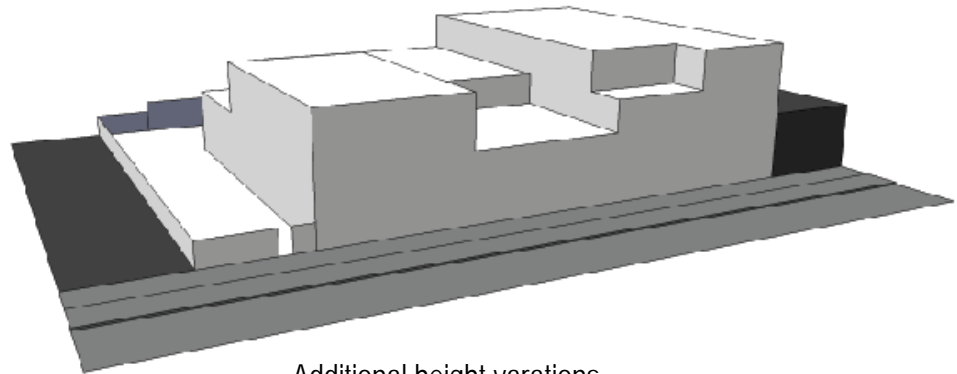
Main St. Facade Studies



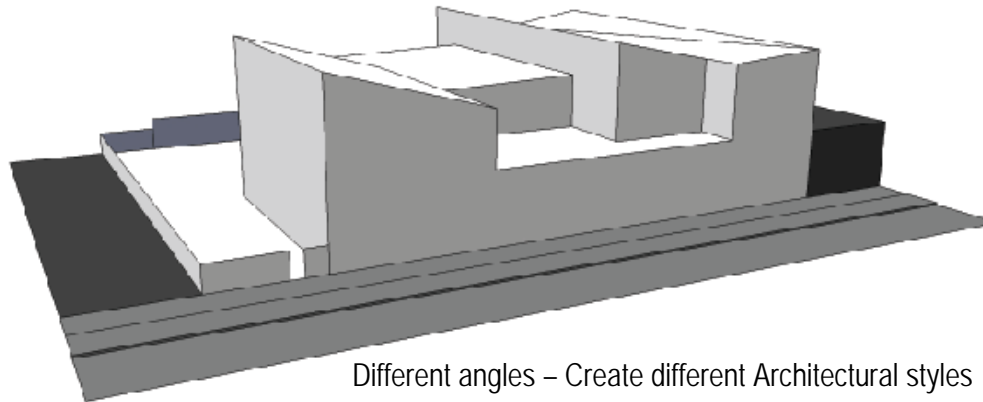
Simple U to create difference – create three masses



More variety in mass

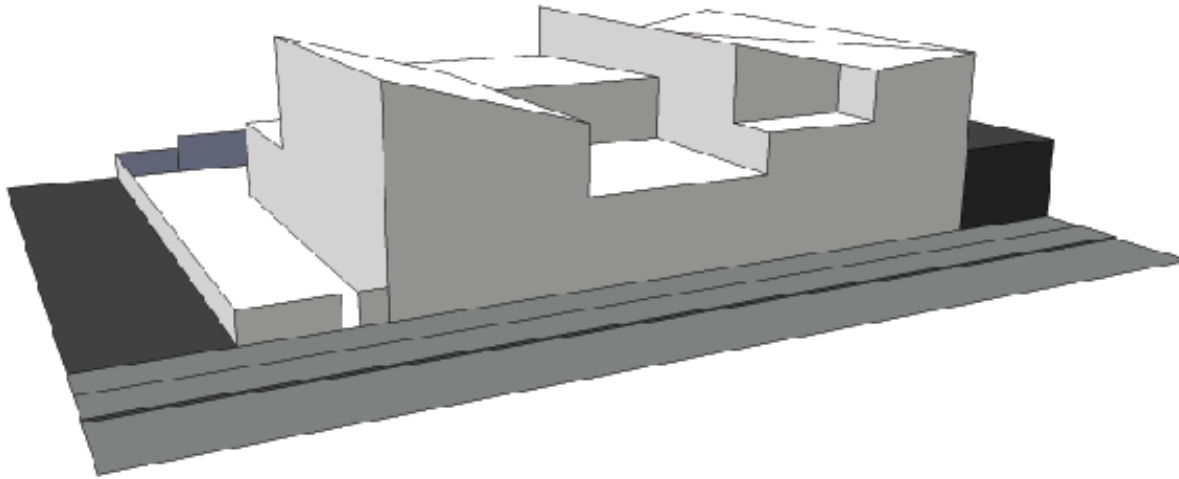


Additional height variations

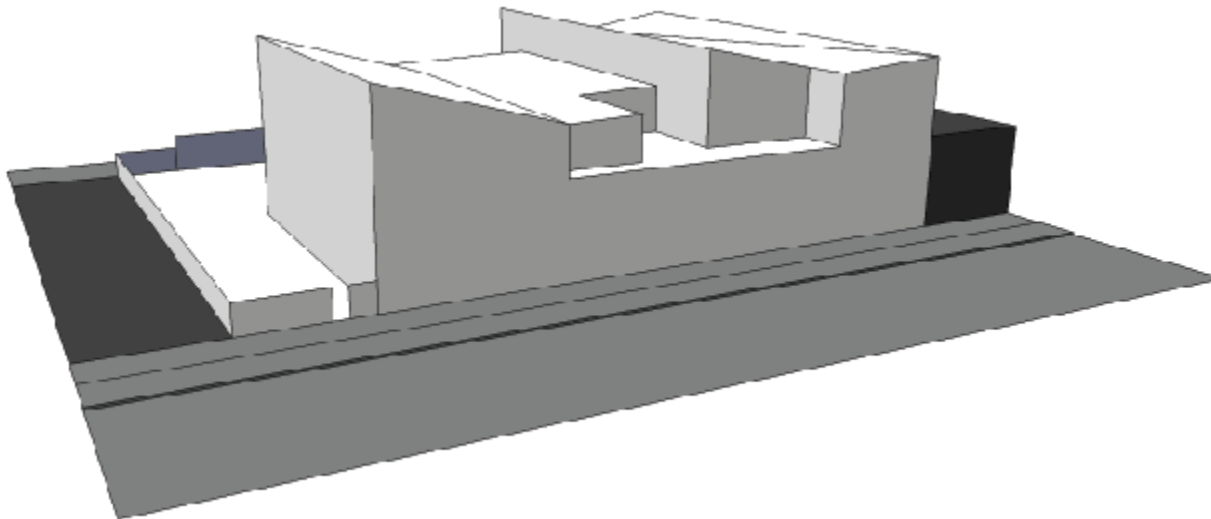


Different angles – Create different Architectural styles

Refining Form



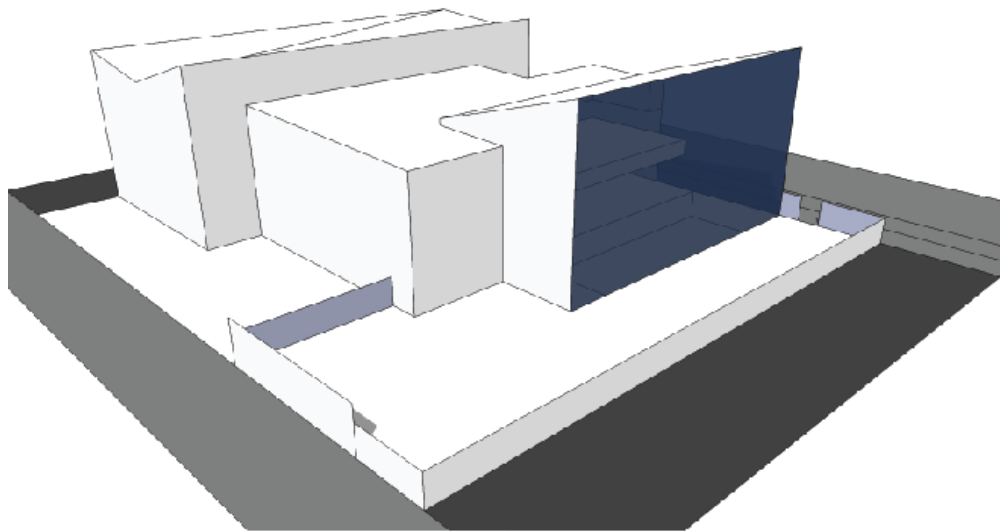
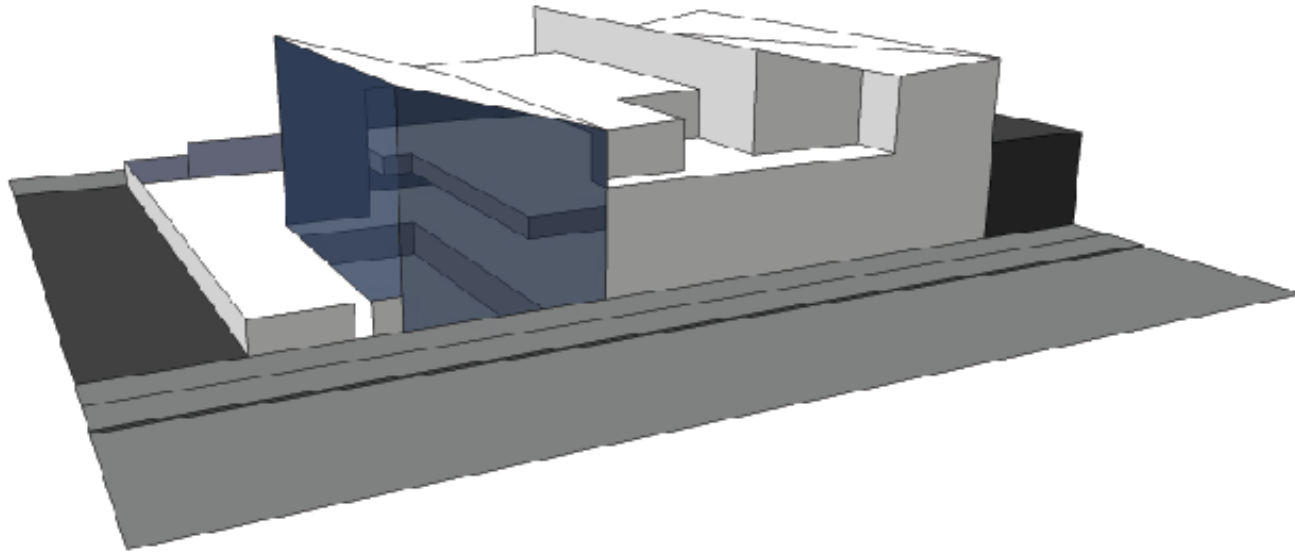
Additional space to the back – cover a larger percentage of the site



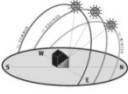
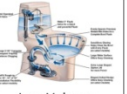







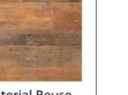
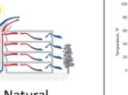
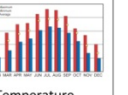





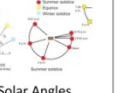

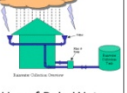
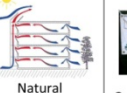

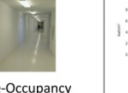



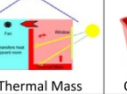


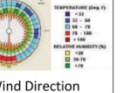





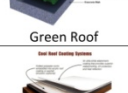
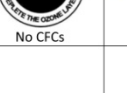


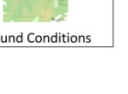

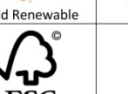



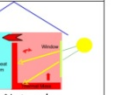



Clarify form – refine levels

Transparency

Glass to give different architectural character, add daylighting, and point of interest



Project Matrix –

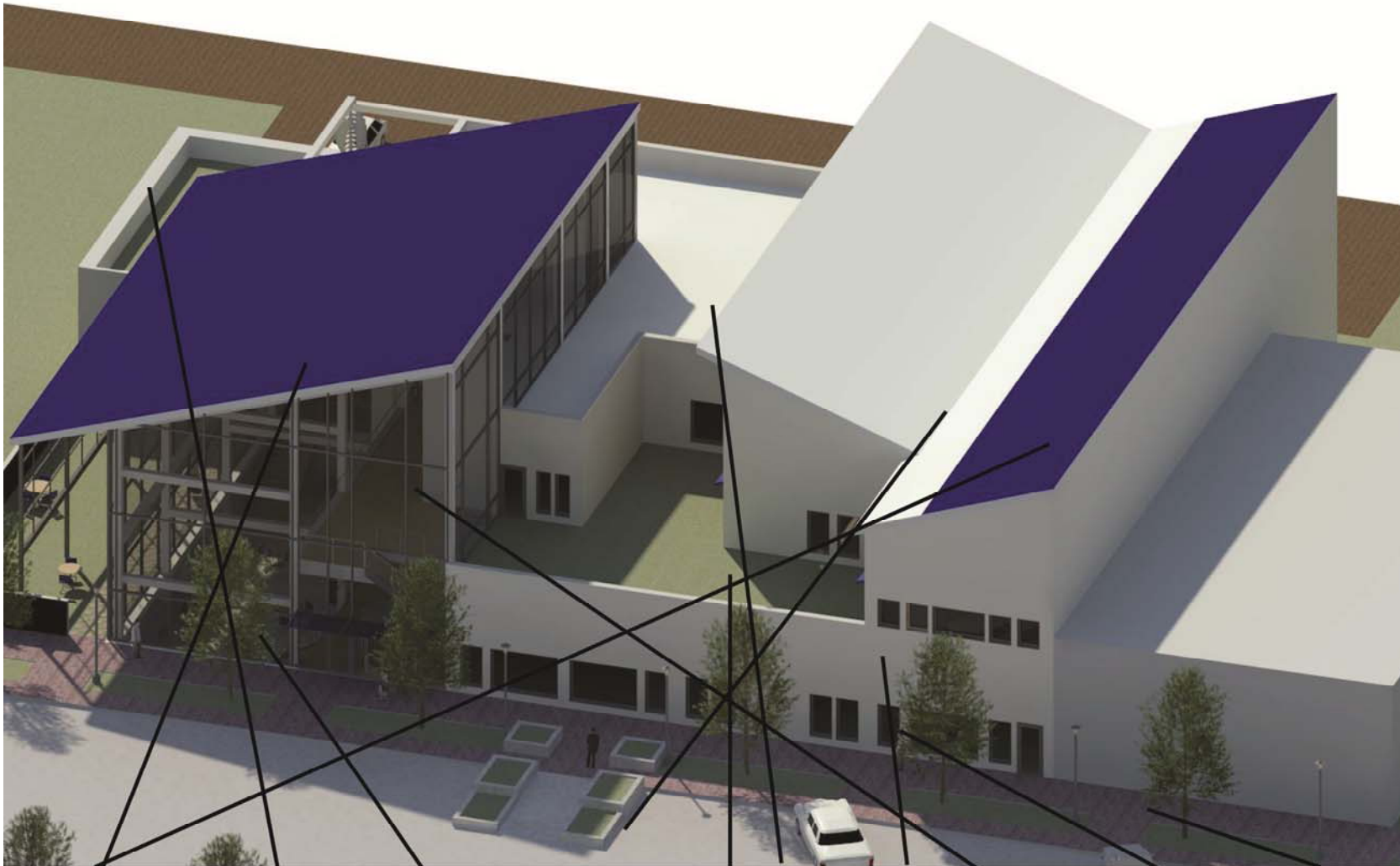
Sustainable Site	Water Efficiency	Energy & Atmosphere	Materials & Resources	Indoor Environmental Quality	Regional Priority
 Solar orientation	 Low Volume Fixtures	 On-site energy	 Recycled Material	 Mechanical	 Moisture
 Community	 Irrigation	 Insulation	 Material Reuse	 Natural	 Temperature
 Collection	 Recycled Grey Water	 Glazing	 Building Reuse	 CO2 Monitors	 Solar Angles
 Treatment	 Use of Rain Water	 Natural Ventilation	 Construction Waste	 Pre-Occupancy	 Solar intensity
 Permeable Pavement	 Water Treatment	 Thermal Mass	 Occupant Waste	 Daylight	 Wind Direction
 Bicycles		 No Refrigerants	 Manufactured	 Mechanical	 Native Plants
 Green Roof		 No CFCs	 Harvest	 Control	 Ground Conditions
 Cool Roof			 Rapid Renewable	 Control	
 Selection			 FSC Certified Wood	 Mechanical	
 Beam Direction				 Natural	
 Automatic					

Each project must develop its own matrix. It is important to have a project matrix that reflects the building type, site, and desired esthetics.

Research into Greensburg's wants, the site and context, and typology of a spec. office building lead to the selection of elements in each area of each category.

Local materials and climate help to determine how each element is used.

See Appendix (pg 108) for complete Project Matrix



Solar panels on the south facing roofs

The existing basement is used

Both green and cool roofs are being used

Only certified or reclaimed wood is used

Permeable pavers are used for all sidewalks



Locally harvested wheat straw bales are used in some walls

Rain can be collected from 80% of the site

Locally manufactured concrete walls

Recycled materials are used throughout

Some of the matrix applied to the project

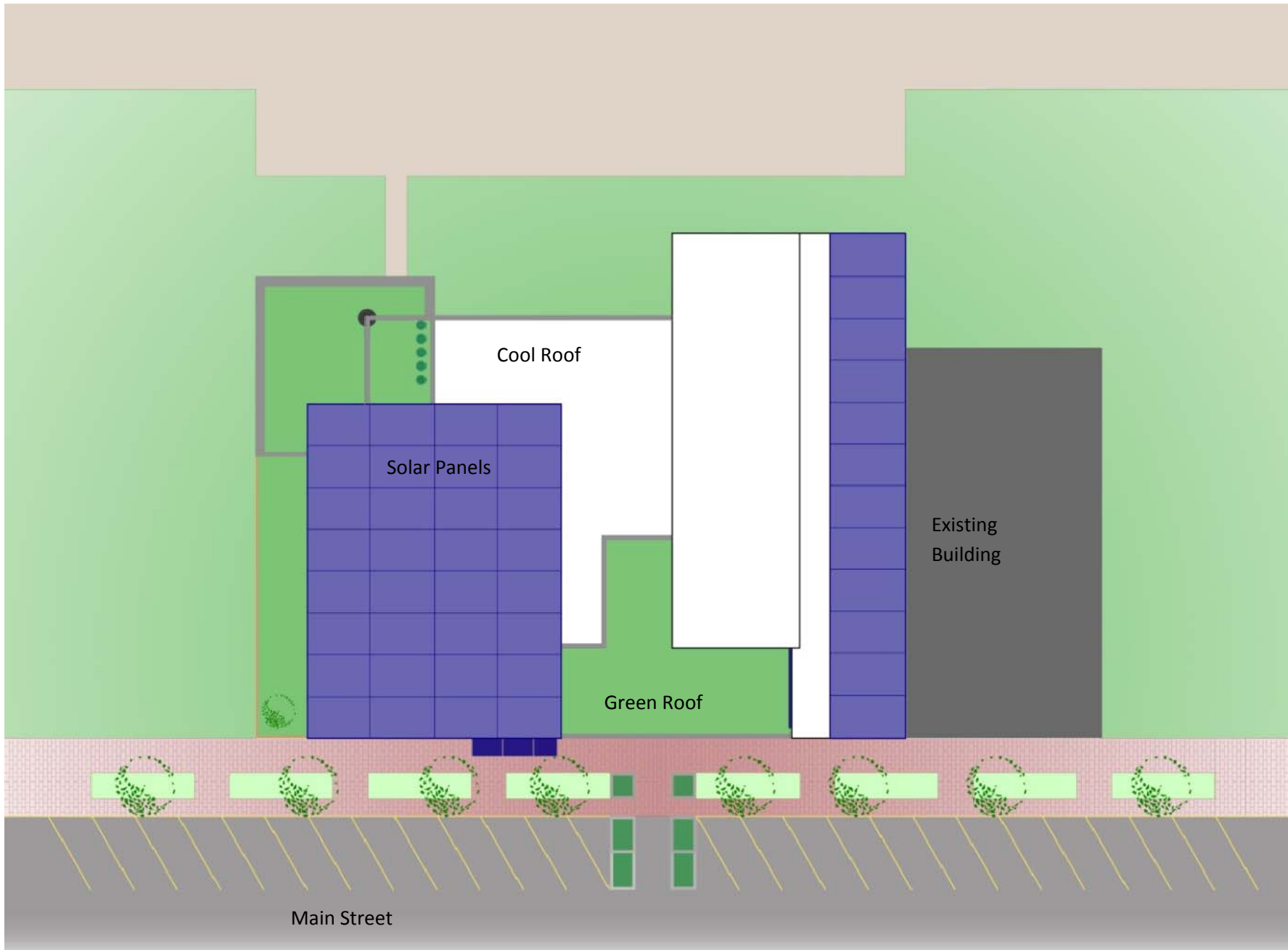
Final Design Documentation

Final images of the project illustrate a sustainable building using designed and technological elements.



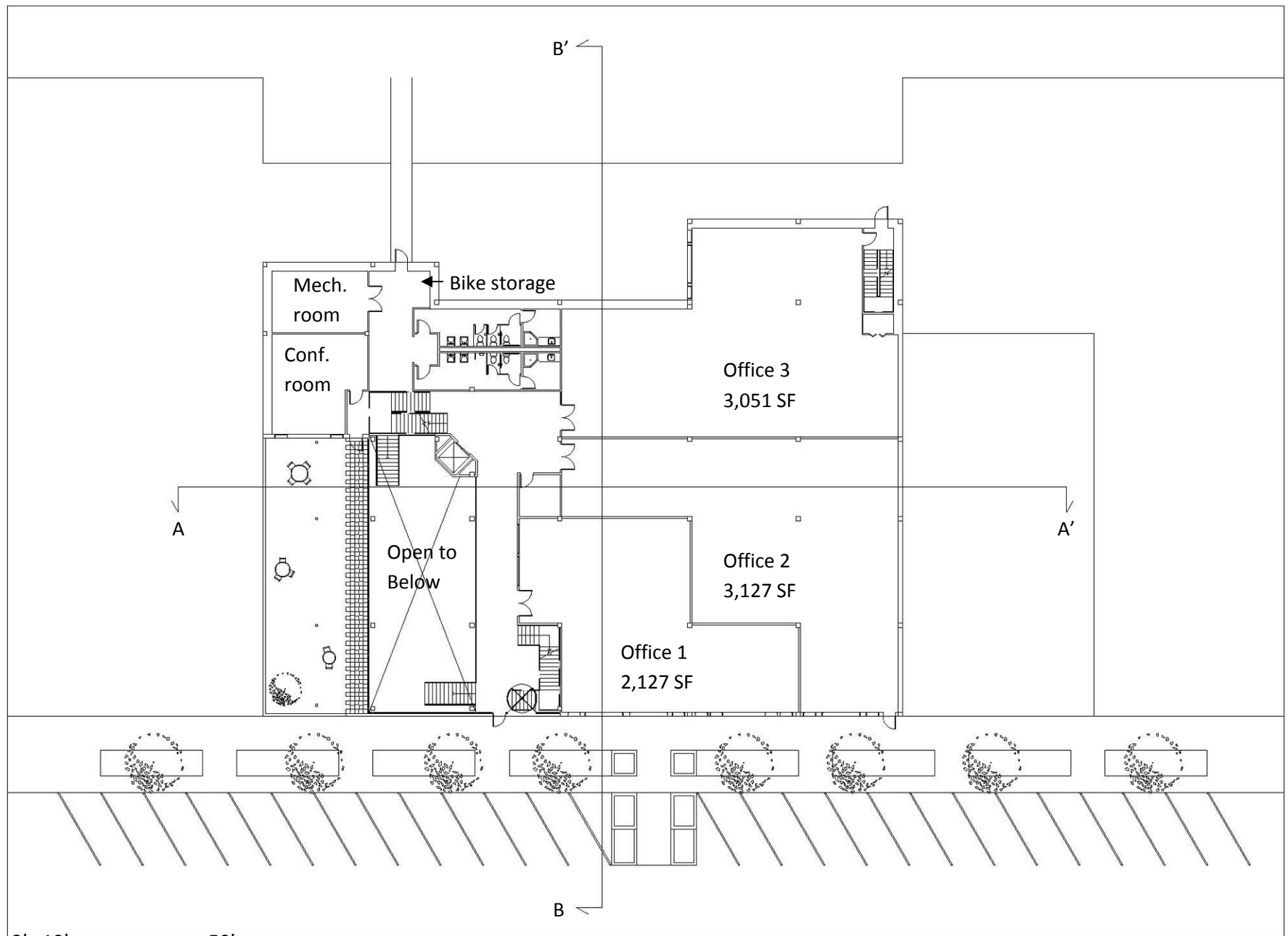




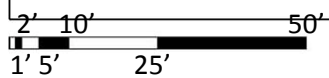
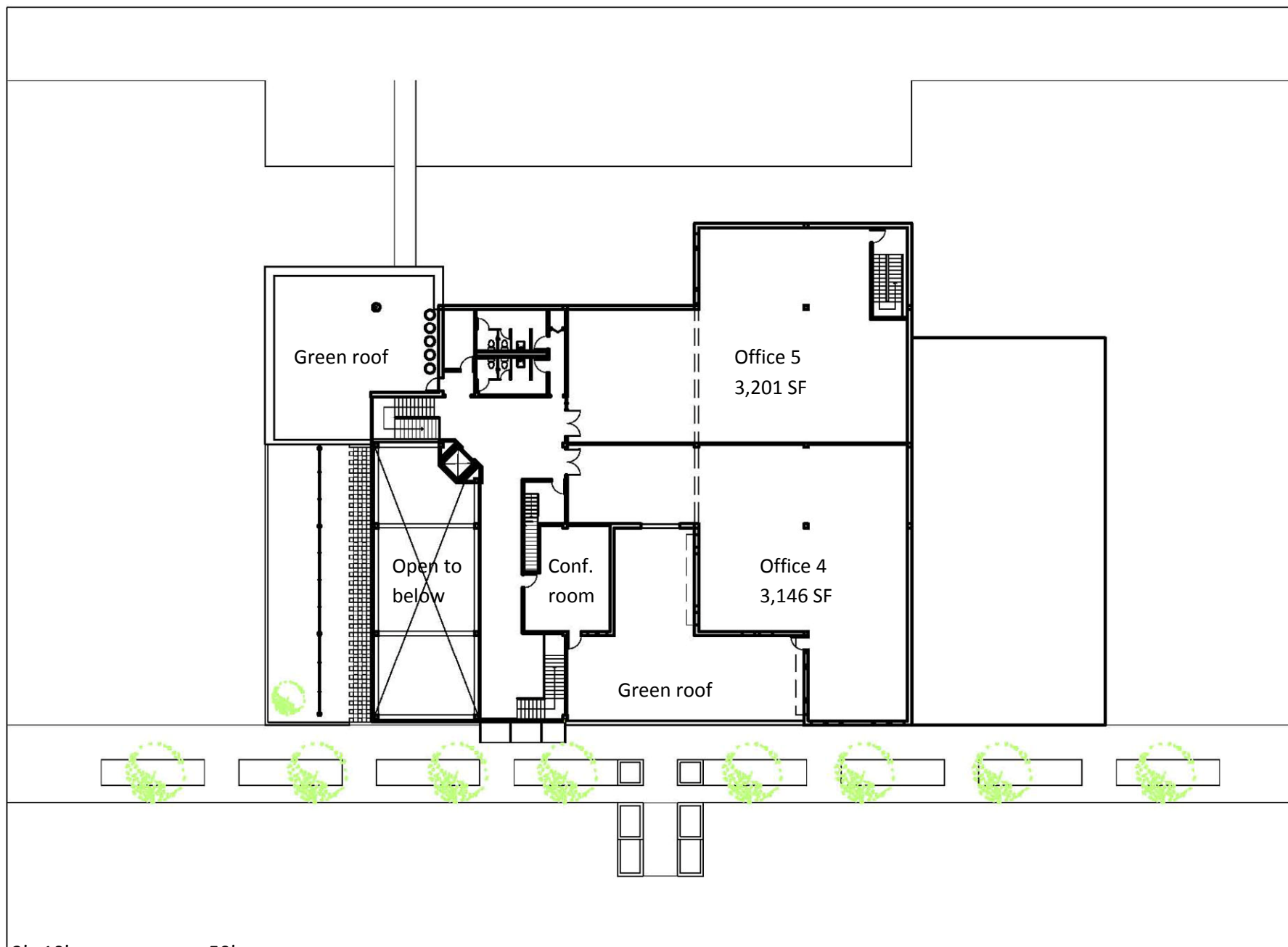


North →

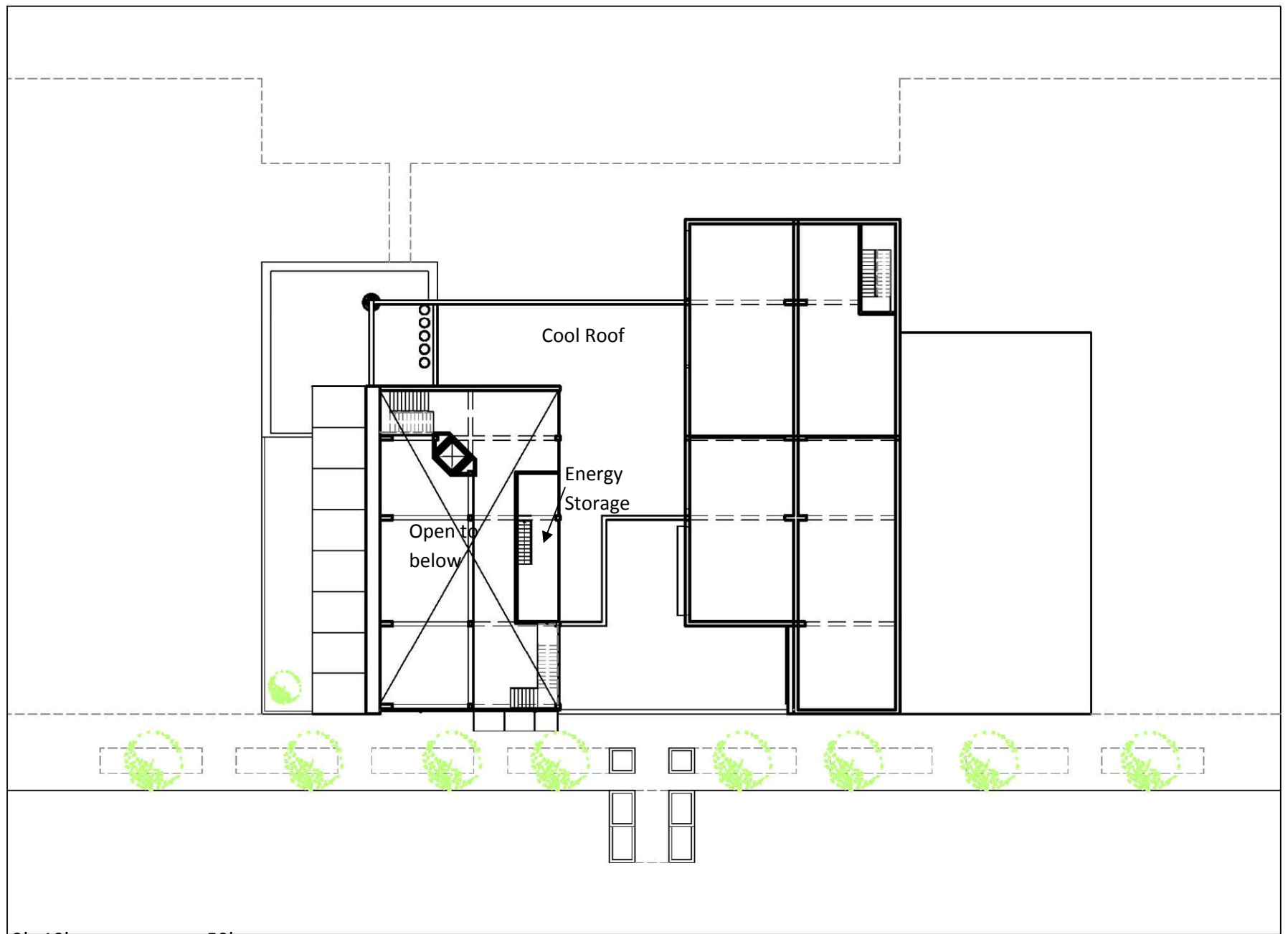
Site Plan



Level 1

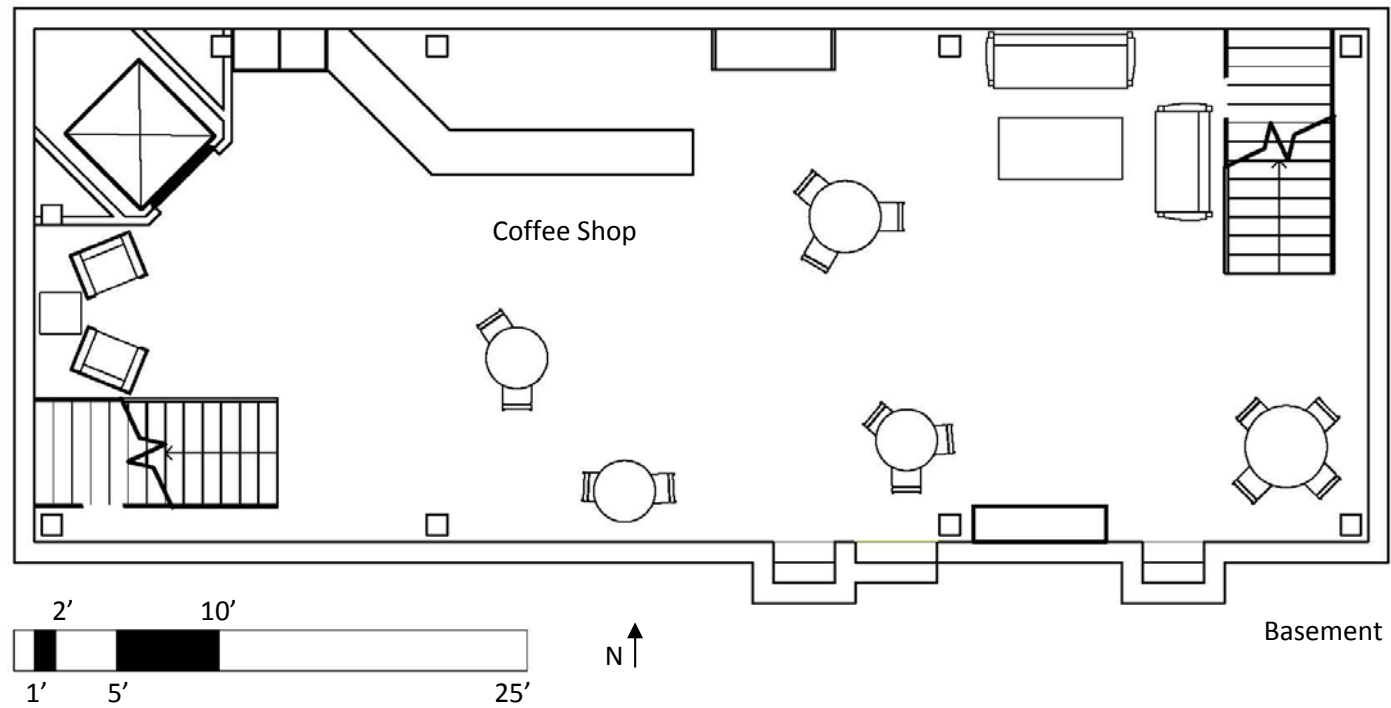


Level 2



2' 10' 50'
1' 5' 25'

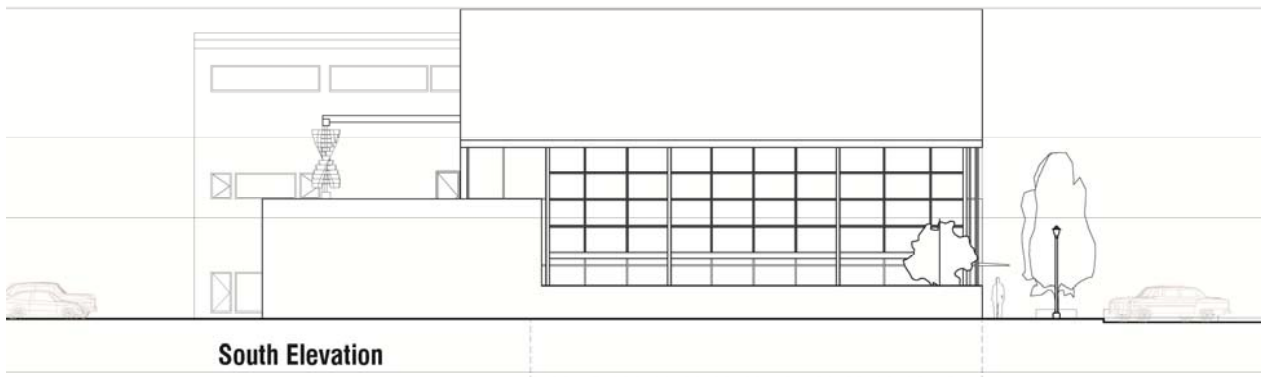
Level 3

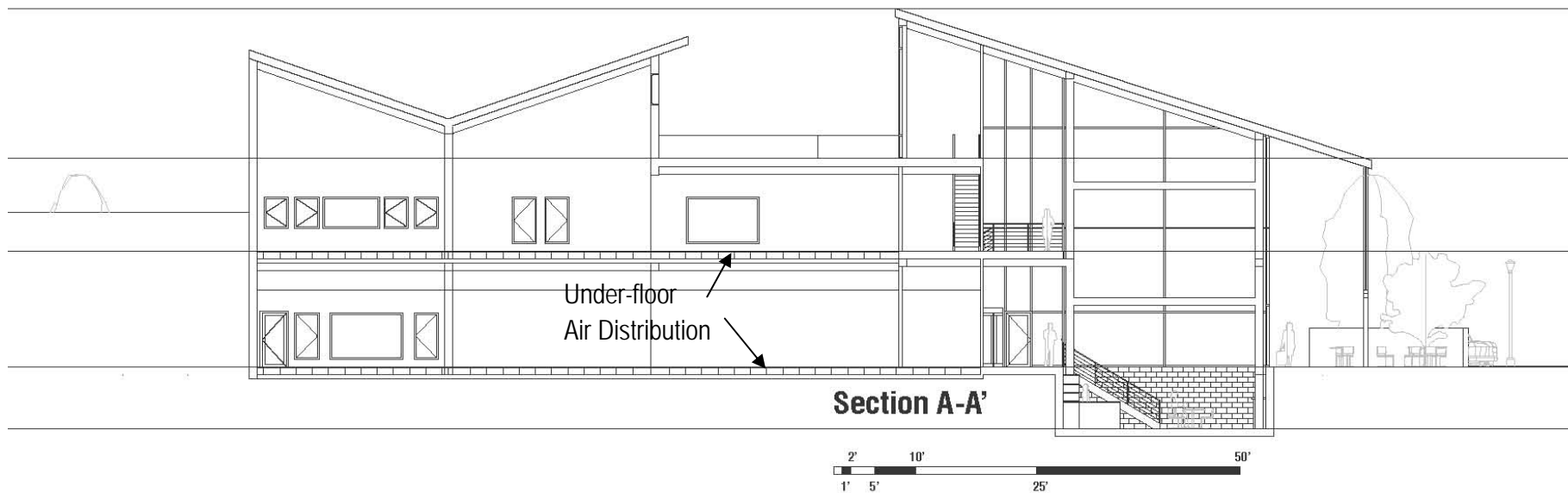


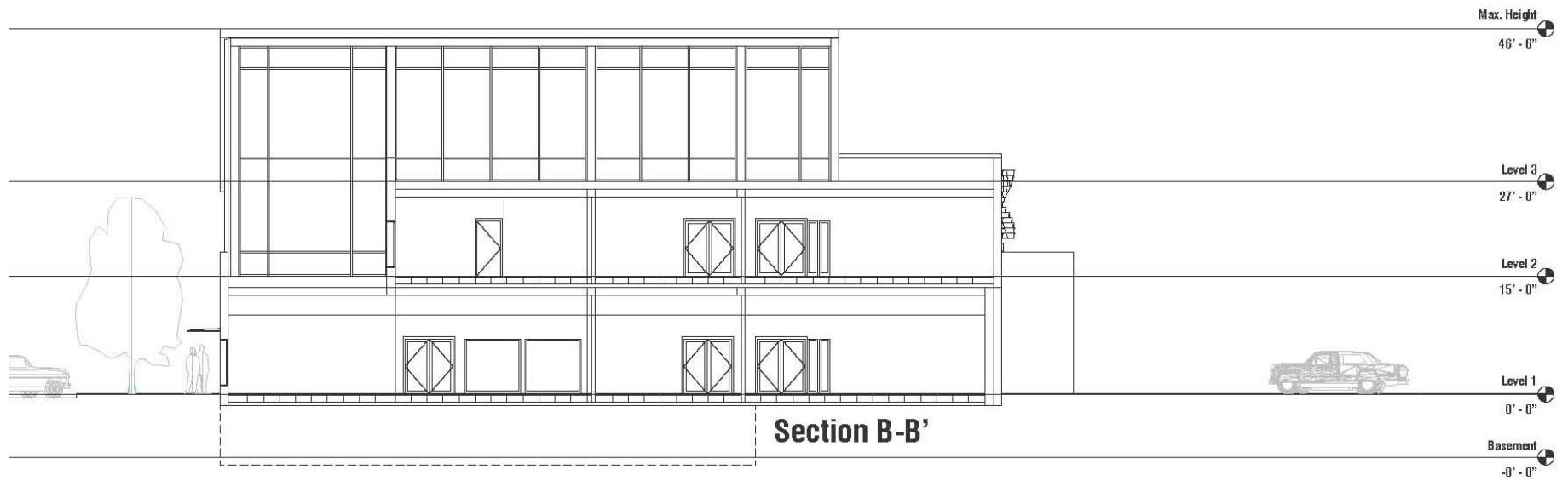
The basement is that of the existing basement structure that is on the site. The fireplace, built-in, and doorways remain.

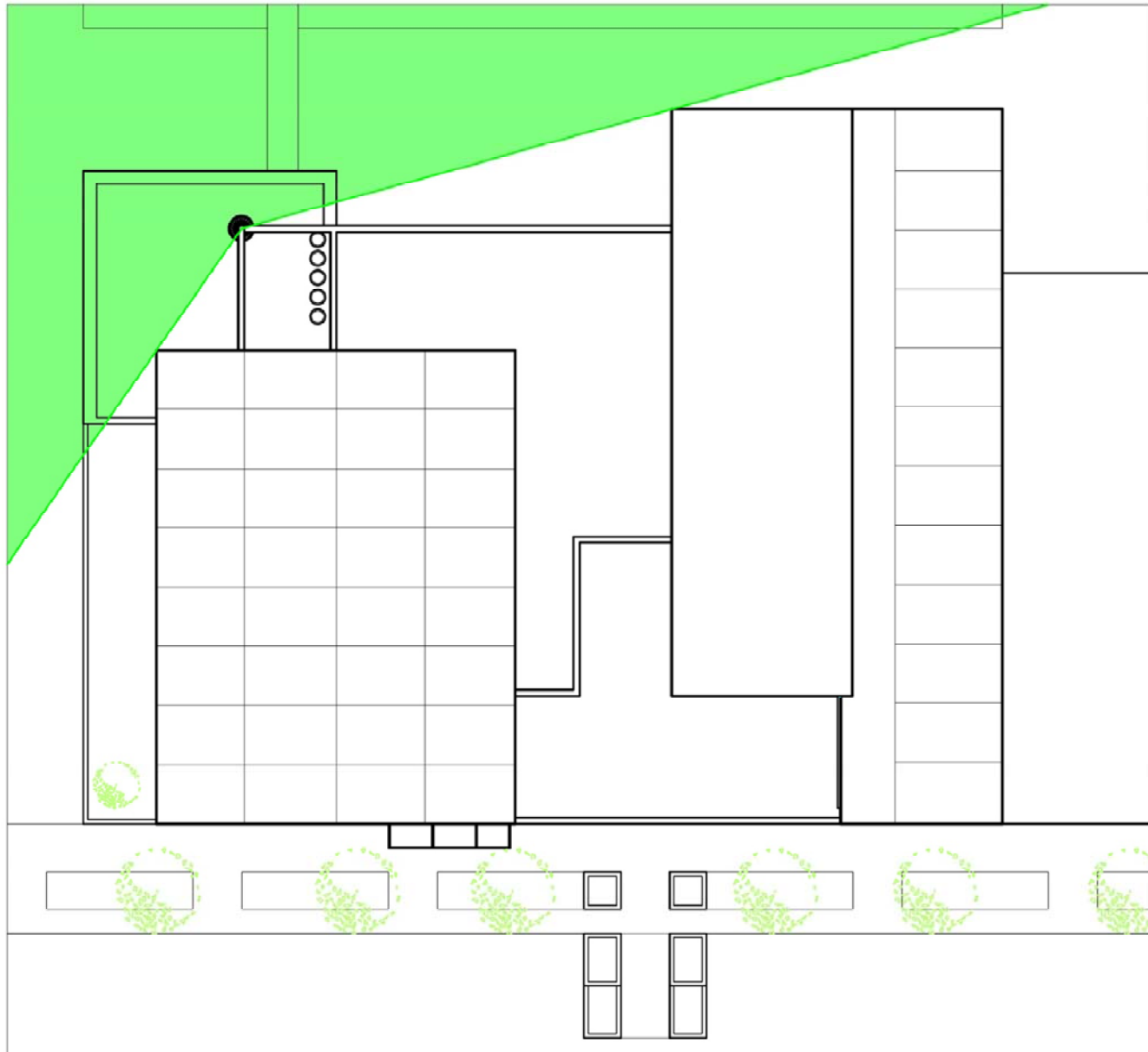








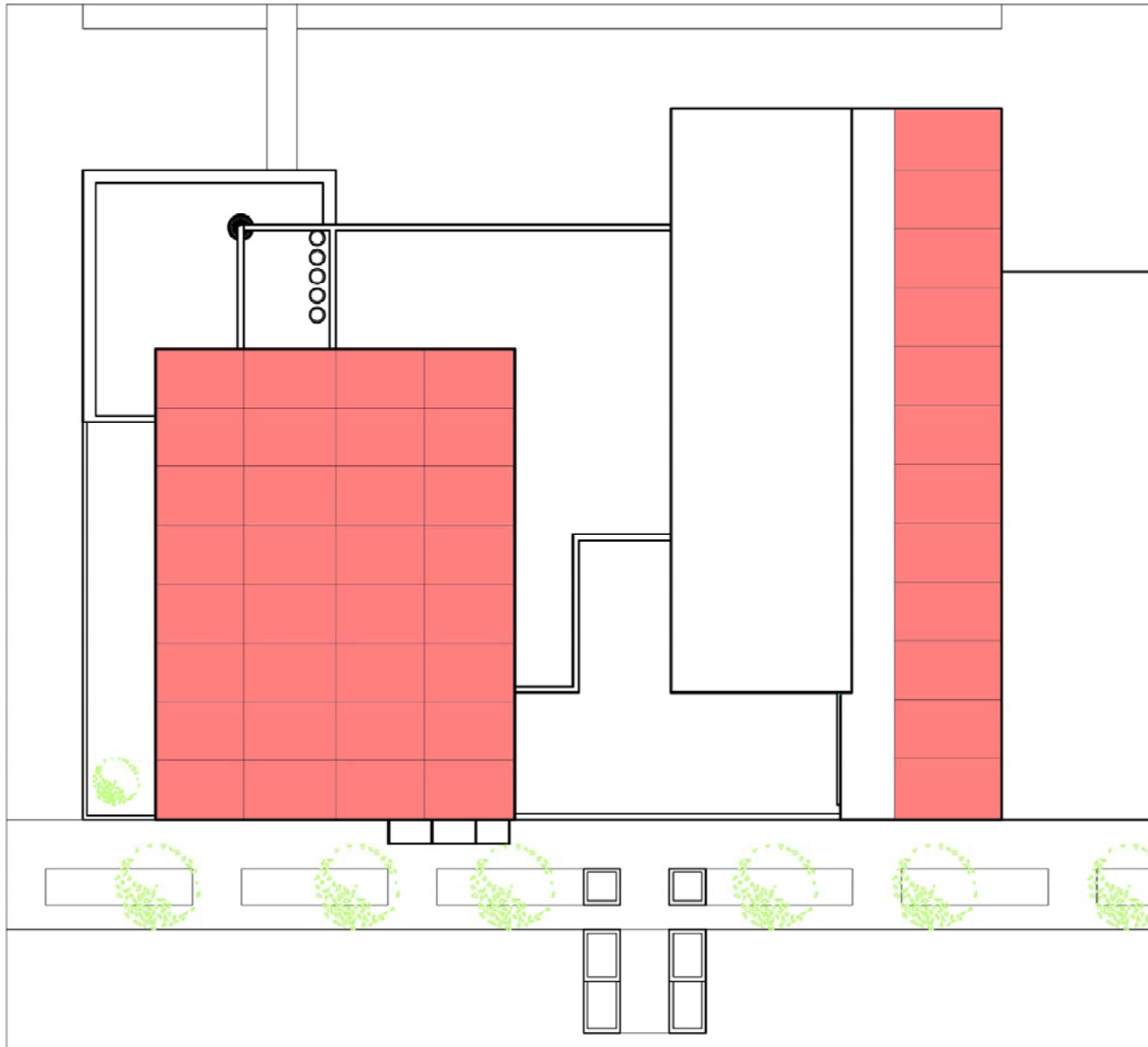




Wind – The wind turbine can harvest wind from the northeast and south: catching the primary wind direction of summer and winter. It can also catch the wind from the west, southwest and southeast.

Wind Energy
2.5 kw wind turbine
13 mph average mean wind speed
≈ 3644 kWh/yr

North →



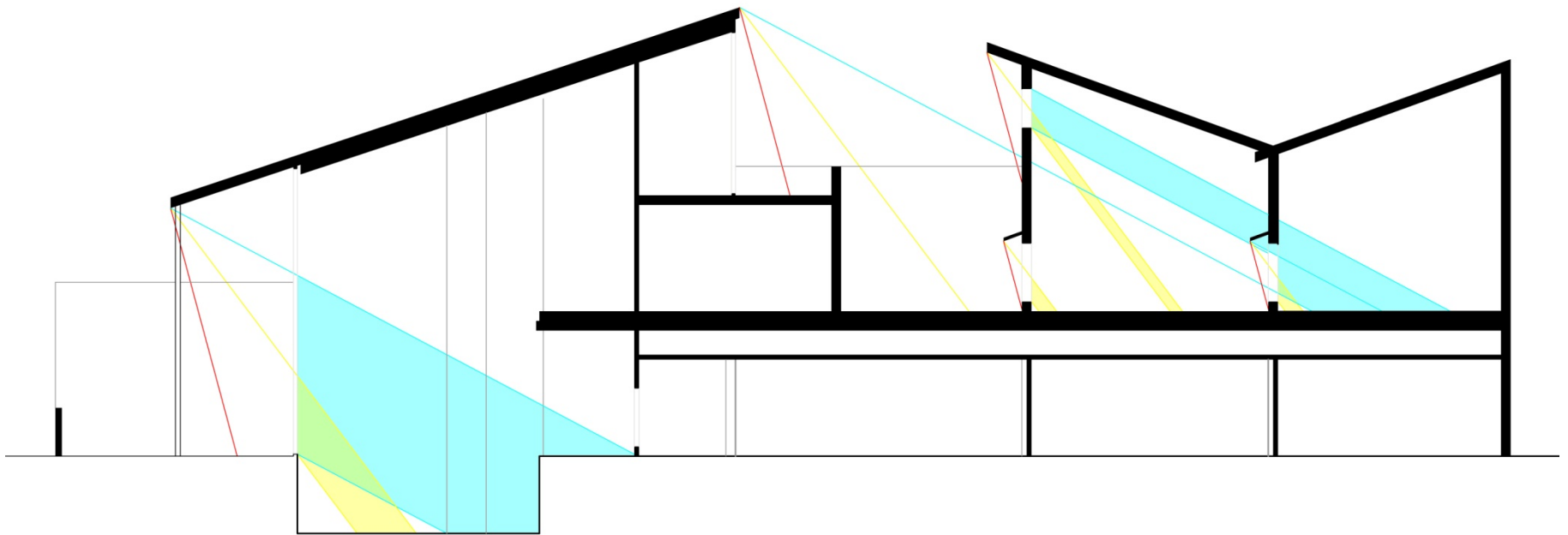
Solar Panels – There are 6,880 Square Feet of solar panels on the south facing roof slopes.

Solar Energy
639.17 Square meters of solar panels
4.93 kWh/m ² average electromagnetic energy
≈ 3,151 kWh/yr
Total energy collected ≈6,795 kWh/yr



Rainwater Collection – Over 13,500 square feet of the roof is used for rainwater collection. The northern portion is a gull-wing collecting the water to the center and draining into a pipe on the west. The middle area is a flat roof with roof drains. The southern single-slope roof drains to the south. The rainwater is collected and stored in rain barrels on the southern green roof and used for irrigation and grey water.

Rainwater Collection	
13,510 Square Feet of collection surface	
22.35 Inches average annual rainfall	
≈ 125,000 gallons per year	



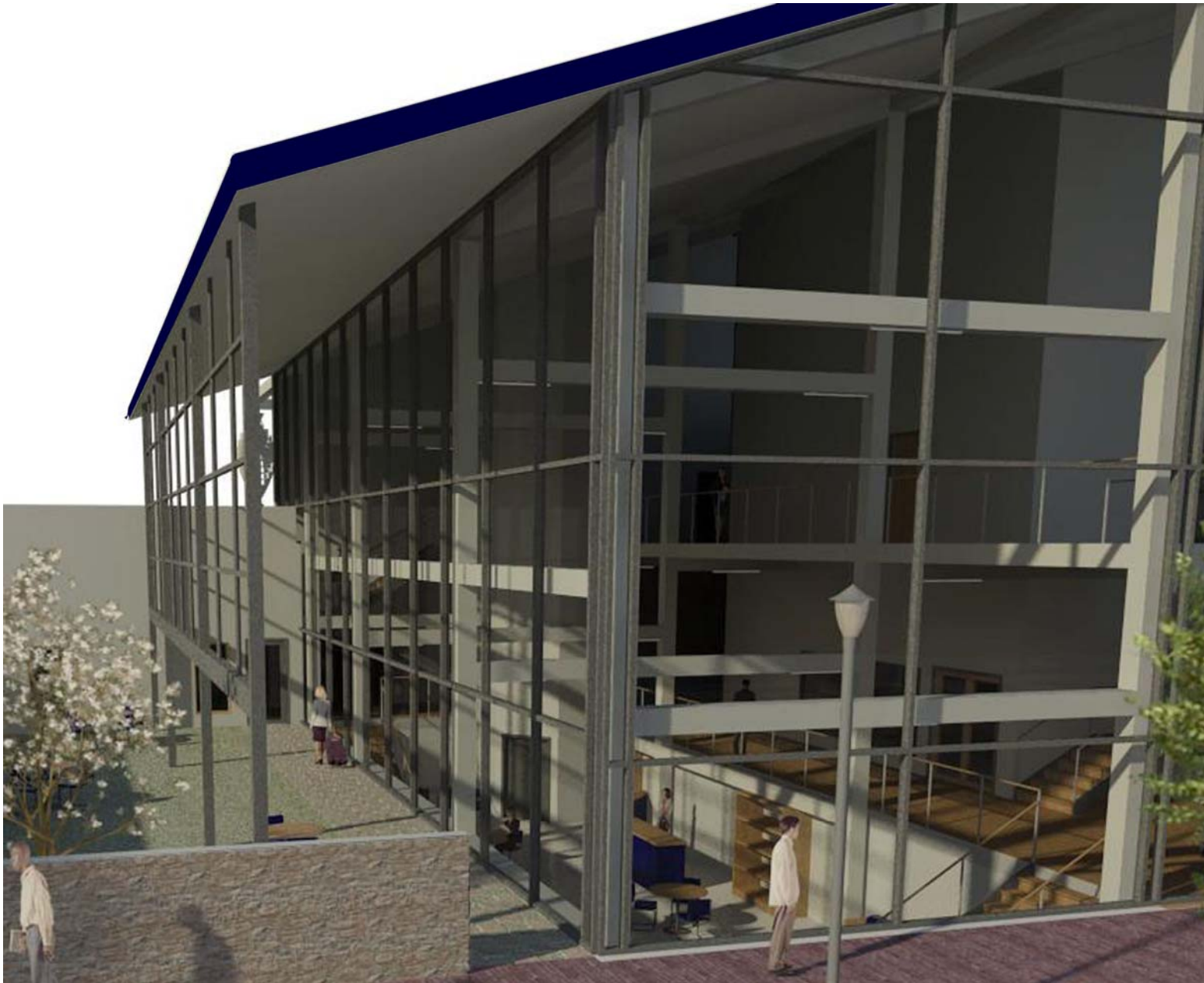
Winter Solstice

Equinox

Summer Solstice

Solar Daylighting

The winter sun is allowed to penetrate deep into the building and is used to help heat the space through solar gain. The summer sun is shaded outside the building to reduce heat gain.



Winter Solstice –
A barren trellis lets
sunlight deep into
the building



Equinox –
Vine plant
grows up the
trellis to shade
the glass from
the sun helping
reduce thermal
gain, allows
diffuse light in



Summer solstice –
Thick vines cover the trellis, shading the glass and a portion of the courtyard, keeping the sun's heat from the building and making the courtyard usable











Conclusion –

The idea of putting together a project through the use of green building elements can lead to a number of different results. Through context; site, user, and typology, the best design can be achieved. It is only at this point that a project can be sustainable.

In this thesis project a great understanding of Greensburg, Kansas was reached. Using climatologic data the building responds to the sun, wind, and rain, and proper mechanical systems and ground coverings were chosen.

Through the city's comprehensive plan and guidelines the building responds to the desires of the citizens and users. This building achieves the aesthetics of being a symbol of their history and progressive spirit. It is a building for the current and future generation.

A speculative office building lends itself well to sustainability. It is the type of building that is rebuilding community needs. Its open floor plan allows for a variety of occupants and changes with little to no energy or waste. The inclusion of community space, coffee shop, and the ability to rent out the conference rooms add additional life to the building beyond the eight hour work day.

The building uses local materials and other green architectural and mechanical elements. Concrete from Greensburg and locally harvested straw bales makes up the highly insulated envelope. Green roofs and cool roofs reduce the heat island effect, while solar panels and a wind turbine collect energy. Rainwater is collected and stored on the site, then reused. The interior is filled with recycled, local, and renewable resources.

The sustainable solution of this thesis project was only reached after piecing together green building elements with site data, users' wishes, and building type.



Bibliography

Attmann, O. (2010). *Green architecture : advanced technologies and materials*. New York: McGraw-Hill.

Average Weather for Greensburg, KS. (2009, September). Retrieved September 2009, from The Weather Channel:
<http://www.weather.com/weather/wxclimatology/monthly/graph/USKS0236>

City of Greensburg, Kansas. (2009, August). Retrieved August 2009, from Official Website of Greensburg, Kansas: <http://greensburgks.org/>

City of Greensburg, Kansas and BNIM. (2008). *Architecture Design Guidelines Checklist*. Greensburg.

City of Greensburg, Kansas and BNIM. (2008). *Atlas*. Greensburg.

City of Greensburg, Kansas and BNIM. (2008). *Greensburg Sustainable Comprehensive Plan*. Greensburg.

City of Greensburg, Kansas and BNM. (2008). *Greensburg Downtown Design Guidelines*. Greensburg.

Greensburg GreenTown. (2009, August). Retrieved August 2009, from Greensburg GreenTown: <http://www.greensburggreentown.org/>

Greensburg GreenTown. (2009, September). *Sustainable Building Database*. Retrieved September 2009, from Greensburg GreenTown:
<http://greensburg.buildinggreen.com/overview.cfm?projectid=1151>

Gurnee, M. (2009, October 19). Community Development Director. (H. Nelson, Interviewer)

LaChiusa, C. (2003). *Larkin Administration Building*. Retrieved October 12, 2009, from History of Buffalo: <http://www.buffaloah.com/h/larkin/admin/index.html>

Mackenzie, D. (1997). *Green design : design for the environment*. London: Laurence King.

Malin, N. (2005, February). *Case Study: Winrock International Global Headquarters*. Retrieved October 2, 2009, from GreenSource Magazine:
<http://greensource.construction.com/printNew.asp?REF>

Marlaire, R. (2009, August 25). *NASA Ames Breaks Ground for 'Greenest' Federal Building Ever*. Retrieved October 2, 2009, from NASA:
http://www.nasa.gov/centers/ames/news/releases/2009/09-108AR_prt.htm

McIntire, J. (2006, April 20). *Another St. Louis Construction Firm Builds LEED-Certified Headquarters*. Retrieved October 3, 2009, from sustainablog: <http://sustainablog.blogspot.com/2006/04/another-st-louis-construction-firm.html>



Melet, E. (1999). *Sustainable architecture : towards a diverse built environment*. Rotterdam: NAI.

Mendler, S., Odell, W., & Lazarus, M. A. (2006). *The HOK guidebook to sustainable design*. Hoboken: J. Wiley.

Murphy, M. (2007, January 3). *Santa Clarita Transit Maintenance Facility Earns LEED® Gold Rating from*. Retrieved October 4, 2009, from PR Web Press Release Newswire: www.hoksustainabledesign.com

Sassi, P. (2006). *Strategies for sustainable architecture*. New York: Taylor & Francis.

Steele, J. (1997). *Sustainable Architecture*. New York: McGraw-Hill.

The Building-Sustainable Features. (2009, May). Retrieved September 11, 2009, from 5.4.7 Art Center: <http://www.547artcenter.org/facility/the-building>

U.S. Green Building Council, Inc. (2009). *Green Building Facts*. Washington D.C.

U.S. Green Building Council, Inc. (2009, April 27). *LEED 2009 for New Construction and Major Renovations*. Retrieved August 2009, from LEED for New Construction: <http://www.usgbc.org/ShowFile.aspx?DocumentID=5546>

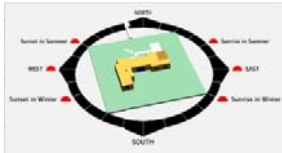







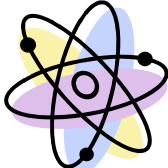












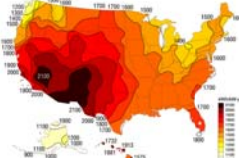
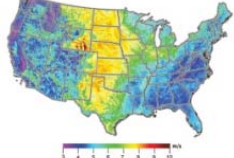

World Architecture New.com. (2009, September 30). *Elithis Tower*. Retrieved October 3, 2009, from Arte Charpentier Architects: <http://www.worldarchitecturenews.com/index.php?fuseaction=wanappln.projectview&up>

Appendix



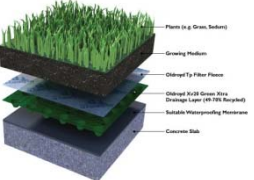

Design Matrix – Use as a master for developing individual project matrix.
Project Matrix – The matrix made especially for this thesis project.
Building Elements – A sample of the green building elements for this project.



Design Matrix – This is the master matrix from which elements can be chosen for the project matrix. Each area has elements within it that can be applied to a project. Looking at the elements characteristics and relationship allow sustainable choices to be made.

Sustainable Site pg M2	 Site	 Storm Water	 Transportation	 Heat Island	 Light Control
Water Efficiency pg M3	 Use Reduction	 Efficient Landscape	 Reuse		
Energy & Atmosphere pg M4	 Energy Generation	 Energy Efficiency	 Manage Refrigerants		
Materials & Resources pg M5	 Recycle/Reuse	 Manage Waste	 Regional	 Renewable	
Indoor Environment Quality pg M6	 Ventilation	 Air Quality	 Lighting	 Thermal Comfort	 Views
Regional Priority pg M7	 Climate	 Solar	 Wind	 Plantings	

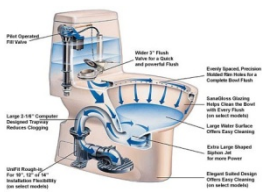
Sustainable Site

					
Site	Brownfield	Solar orientation	Open space	Return to Natural	Community
					
Storm Water	Collection	Treatment	Permeable Pavement		
					
Transportation	Access to Public Transit	Bicycles	Alternative vehicles	Reduce Parking	
					
Heat Island	Green Roof	Cool Roof – pg S14	Living Wall	Reduce Pavement	
					
Light Control	Selection	Placement	Beam Direction	Reduce Reflection	Automatic

Water Efficiency



Use Reduction



Low Volume Fixtures



Efficient Landscape



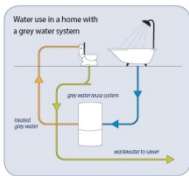
Irrigation – pg W2



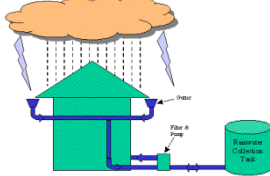
Plant selection



Reuse



Recycled Grey Water

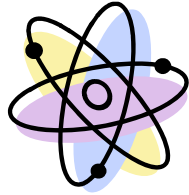


Use of Rain Water



Water Treatment

Energy and Atmosphere



Energy Generation



On-site energy – pg E1



Use Clean Energy



Energy Efficiency



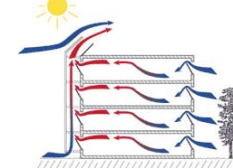
HVAC – pg E3



Insulation



Glazing



Natural Ventilation



Thermal Mass



Refrigerant Management



No Refrigerants



No CFCs

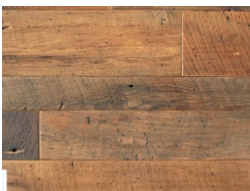
Materials and Resources



Recycle/Reuse



Recycled Material



Material Reuse



Building Reuse



Waste Management



Construction Waste



Occupant Waste



Regional Materials



Manufactured



Harvest – pg M7



Recovered



Renewable



Rapid Renewable



Certified Wood

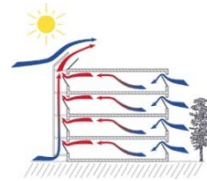
Indoor Environmental Quality



Ventilation



Mechanical



Natural



CO₂ Monitors



Air Quality



Restrict Smoking



Pre-Occupancy



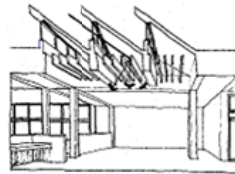
Low-Emitting



Containment



Lighting



Daylight



Mechanical



Control – pg Q10



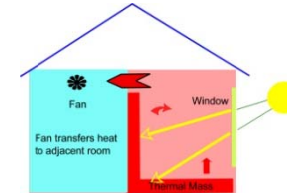
Thermal Comfort



Control



Mechanical – pg E3



Natural



Views

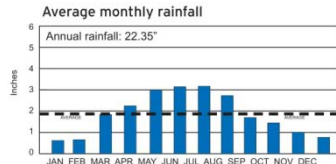


Natural

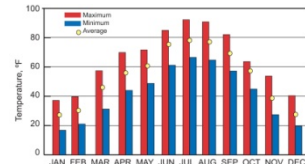
Regional Priority



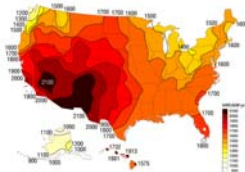
Climate



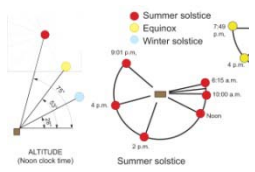
Moisture



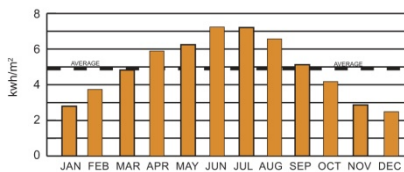
Temperature



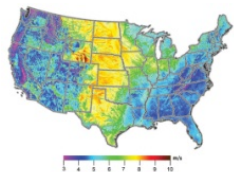
Solar



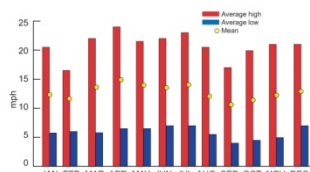
Solar Angles – pg R3



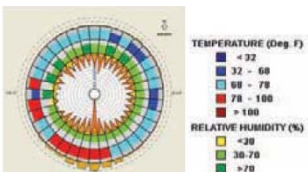
Solar intensity



Wind



Wind Speed



Wind Direction



Plantings



Planting Zones



Native Plants



Ground Conditions

Green Building Elements – This is just a small sample of the building elements that are contained in the matrix. Each page describes the characteristics, functional relationship with other elements and the building design, benefits, and limitations of the element. This will help to determine what will work for a project and how they work with other elements.

COOL ROOF / HEAT ISLAND / SUSTAINABLE SITE



FUNCTIONAL RELATIONSHIPS:

POSITIVE:

Good with most roof types and shapes.
Can be used with Storm Water Collection systems. Energy efficient.

NEGATIVE:

Can not be used with a Green Roof system,
can be used next to one.

CHARACTERISTICS:

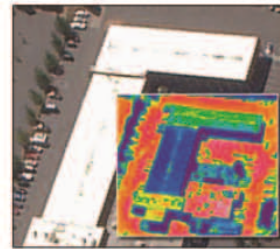
Comes in a variety of styles that may be appropriate for different building/roof type. Can be selected from a variety of colors and materials. Each has their own solar reflectance and thermal emittance.

BENEFITS:

Reflects heat, Energy savings, Works in a variety of locations and roof type, Aids in the mitigation of the urban heat island.

LIMITATIONS:

Does not work on every roof in every location, Over time climate, solar radiation and pollution can reduce solar reflectance, Requires regularly scheduled upkeep and cleaning



IRRIGATION / EFFICIENT LANDSCAPE / WATER EFFICIENCY

FUNCTIONAL RELATIONSHIPS:



POSITIVE:

Using collected storm water, reusing grey water and/or open ended ground source heat pump as a water source. Working with the selection and placement of plants and sprinkler locations aid in a more controlled and even watering. Permeable pavement reduces any run off.

NEGATIVE:

If not used correctly it can be waste water. Using potable water.

CHARACTERISTICS:

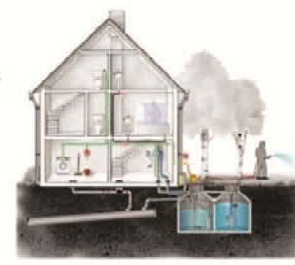
Deliberate and controlled watering of the landscape.

BENEFITS:

Beautifying and supporting landscape and site.

LIMITATIONS:

Require the use of water for non human need.



ON-SITE ENERGY / ENERGY GENERATION / ENERGY & ATMOSPHERE



Photovoltaic Energy



Solar Hot Water Heating

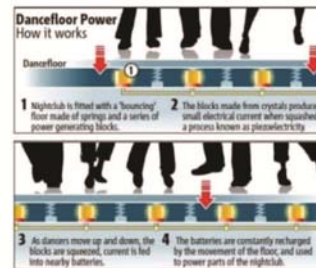


Thermal Mass
Radiant Heating

On-site energy generation can include one or more



Wind Turbines - pg E1D



Kinetic Floor



Low-impact Hydroelectric

E1

Some areas have many options to them and can become many different elements.

WIND TURBINE/ ON SITE ENERGY/ ENERGY GENERATION/ ENERGY AND ATMOSPHERE



FUNCTIONAL RELATIONSHIPS:

POSITIVE:

Use the roof lines and building shape to accelerate wind speeds and focus wind direction to get the most out of the wind turbine.

NEGATIVE:

They can effect the wind conditons on the site. Free-standing turbines may require a fall zone according to codes. Some don't like the looks of wind turbines

CHARACTERISTICS:

VERTICAL AND HORIZONTAL WIND TURBINES CAN BE ATTACHED TO THE BUILDING OR FREE-STANDING ON THE SITE

BENEFITS:

Produce energy for building use or to sell back to the grid.

LIMITATIONS:

Turbines need to be positioned so that the primary wind direction is harvested. The wind has to be blowing.



HVAC/ ENERGY EFFICIENCY/ ENERGY AND ATMOSPHERE MECHANICAL/ THERMAL CONTROL/ INDOOR ENVIRONMENTAL QUALITY



FUNCTIONAL RELATIONSHIPS:

POSITIVE:

Use with natural ventilation and passive heating and cooling methods to reduce the load. Use energy generation to power the mechanical system.

NEGATIVE:

Can use excessive energy.

CHARACTERISTICS:

USE ENERGY EFFICIENT HVAC SYSTEMS THAT FILTER THE AIR AND PRODUCE HEALTHY AIR.

BENEFITS:

Produce healthy air at comfortable temperatures.

LIMITATIONS:

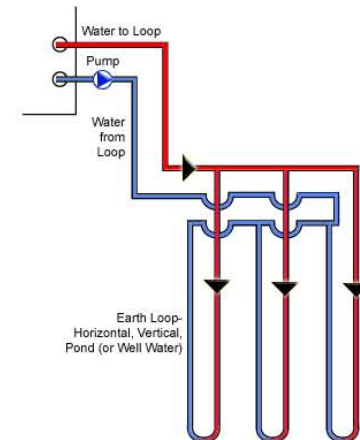
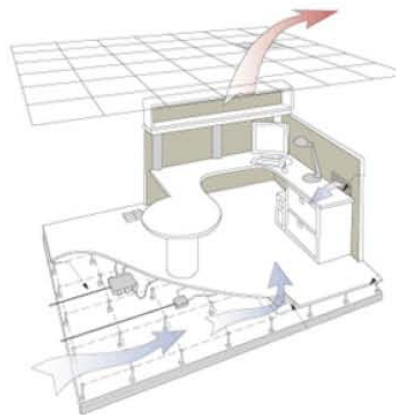
Requires area for the cooling towers or well-fields.



A heat pump heats your home in the winter...



and cools your home in the summer.



HARVEST / REGIONAL MATERIALS / MATERIALS AND RESOURCES



FUNCTIONAL RELATIONSHIPS:

POSITIVE:

Raw materials refined locally. Materials can be used traditionally or innovatively to improve the success of the building.

NEGATIVE:

Small scale harvest may be inefficient and use excessive amounts of energy or resources.

CHARACTERISTICS:

The gathering of raw goods from the region of a particular design project. Refined or Manufactured for the use in construction and finish of the building.

BENEFITS:

Reduce shipping needs. Improve local economy.

LIMITATIONS:

Limits to the regional materials.

Greensburg, KS.
harvested materials.

Must re-examine for
each location.



CONTROL / LIGHTING / INDOOR ENVIRONMENTAL QUALITY



FUNCTIONAL RELATIONSHIPS:

POSITIVE:

Time studies of solar angles. Understanding solar heat gain. Use with mechanical lighting system. Give individual control and directional or task light.

NEGATIVE:

Blocks views. Thermal mass could not gain the heat.

CHARACTERISTICS:

An individual has a need and right to be able to control the amount, type and quality of light of the space that they are occupying.

BENEFITS:

Adjustable shading allows for the majority to be satisfied.

LIMITATIONS:

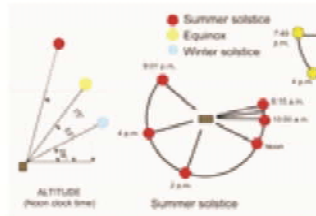
Cannot make everyone happy. Problems with even distribution of light.



Q10

SOLAR ANGLES / SOLAR / REGIONAL PRIORITY

FUNCTIONAL RELATIONSHIPS:



POSITIVE:

Work with sun shading and louvers size and placement. Photovoltaic placement. Daylighting. Shading/Shadow patterns and paths. Solar heat gain calculates into location of natural and mechanical HVAC.

NEGATIVE:

Over design for daylighting.

CHARACTERISTICS:

The study of where the sun is in sky at any given hour, day or month. Examine the effects that these angles will have on your project.

BENEFITS:

Daylighting. Energy generation. Reduction of HVAC need.

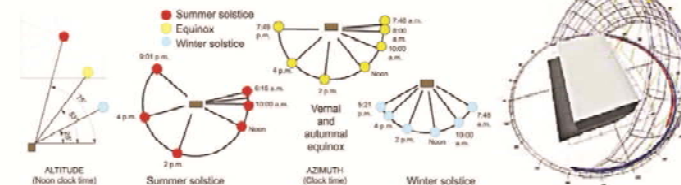
LIMITATIONS:

Surrounding of the project may change and alter the solar affect.



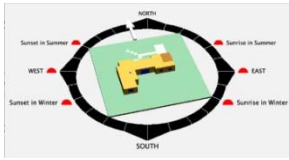
Greensburg, KS. sun angles.

Must re-examine for each location.

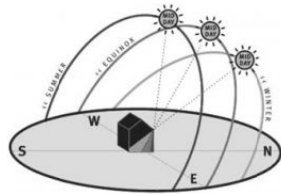


Project Matrix – The following elements are the ones that are being used in this thesis project. References can be made back to the matrix elements. These elements were chosen on their relationships with each other, the site, building type, and users' wishes.

Sustainable Site



Site



Solar orientation



Community



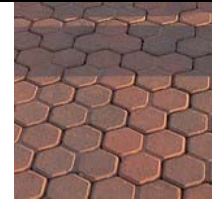
Storm Water



Collection



Treatment



Permeable Pavement



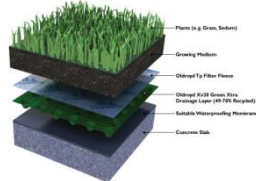
Transportation



Bicycles



Heat Island



Green Roof



Cool Roof



Light Control



Selection



Beam Direction

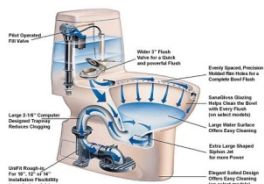


Automatic

Water Efficiency



Use Reduction



Low Volume Fixtures



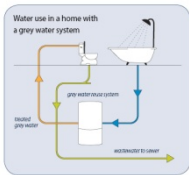
Efficient Landscape



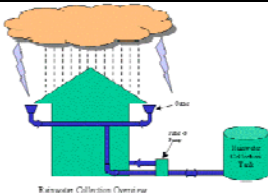
Irrigation



Reuse



Recycled Grey Water

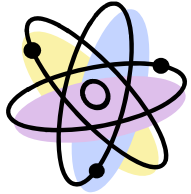


Use of Rain Water



Water Treatment

Energy and Atmosphere



Energy Generation



On-site energy



Energy Efficiency



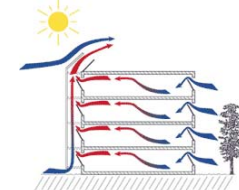
HVAC



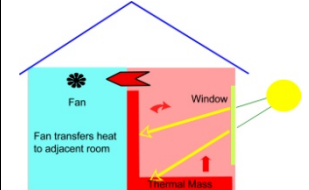
Insulation



Glazing



Natural Ventilation



Thermal Mass



Refrigerant Management



No Refrigerants



No CFCs

Materials and Resources



Recycle/Reuse



Recycled Material



Material Reuse



Building Reuse



Waste Management



Construction Waste



Occupant Waste



Regional Materials



Manufactured



Harvest



Renewable



Rapid Renewable



Certified Wood

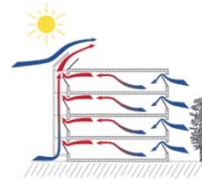
Indoor Environmental Quality



Ventilation



Mechanical



Natural



CO₂ Monitors



Air Quality



Pre-Occupancy



Low-Emitting



Lighting



Daylight



Mechanical



Control



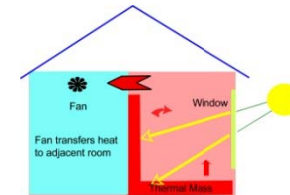
Thermal Comfort



Control



Mechanical



Natural



Views

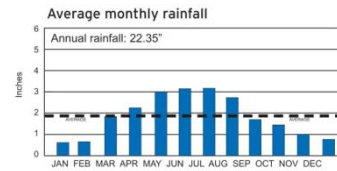


Natural

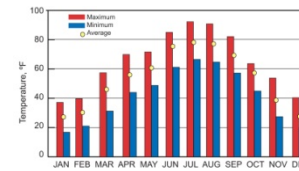
Regional Priority



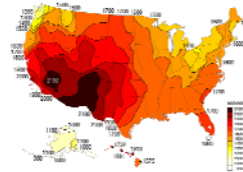
Climate



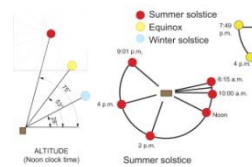
Moisture



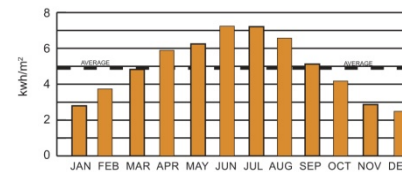
Temperature



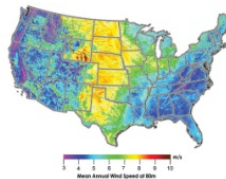
Solar



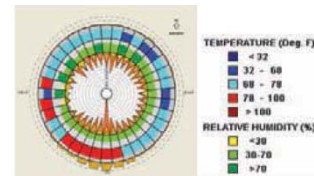
Solar Angles



Solar intensity



Wind



Wind Direction



Plantings



Native Plants



Ground Conditions

Acknowledgements and Dedications

I want to thank all of you who have been involved with the last six years of my life. I have grown from the knowledge, friendship, and memories that will last a lifetime.

I dedicate this book to –

Mom and Dad, Thank you for always being there for me. I know that you are only a phone call away. Thanks for raising me the way you did, making me who I am for today and tomorrow. Your love means the world to me.

Amy, Thank you for being my best friend. It is hard to believe that I didn't even know you when I started in Architecture. And now, well you can finish this sentence.

Sharon Kuska, Thank you for being my thesis advisor. Your guidance and knowledge through the past year has been vast. I will miss our weekly meetings.

